digital

hardware

**DECstation
user's guide**

PDP8

more than 30,000 installed worldwide

DECstation
user's guide

EK-VTX78-UG-001

This document was set on DIGITAL's DECset-8000
computerized typesetting system.

CONTENTS

CONTENTS (CONT)

FIGURES

TABLES

TABLES (CONT)

INTRODUCTION

Your DECstation is a complete computer in a terminal. It has a processor, a 16K word memory, and a keyboard/video display – and it does not need much more space than a conventional typewriter.

The DECstation (Figure 1) can be used as a simple I/O device, as an intelligent terminal in a distributed data processing network, or as a standalone computer. Figure 2 shows a typical standalone computer configuration.

The system is easy to install and even simpler to operate. Just unpack the equipment, connect the cables, and follow the simple operating steps described in this guide. Your system will be ready to run in a matter of minutes.

Built-in diagnostics automatically check your system's performance each time you turn it on. Should a malfunction occur, these diagnostics will also pinpoint the trouble for faster maintenance, ensuring minimum downtime.

This guide contains information that will help you install, operate, and program your DECstation. It also contains troubleshooting information designed to help isolate minor problems that are not equipment malfunctions. Although some RX78 floppy disk drive system information has been included in this guide for your convenience, refer to the appropriate manuals for more detailed information.
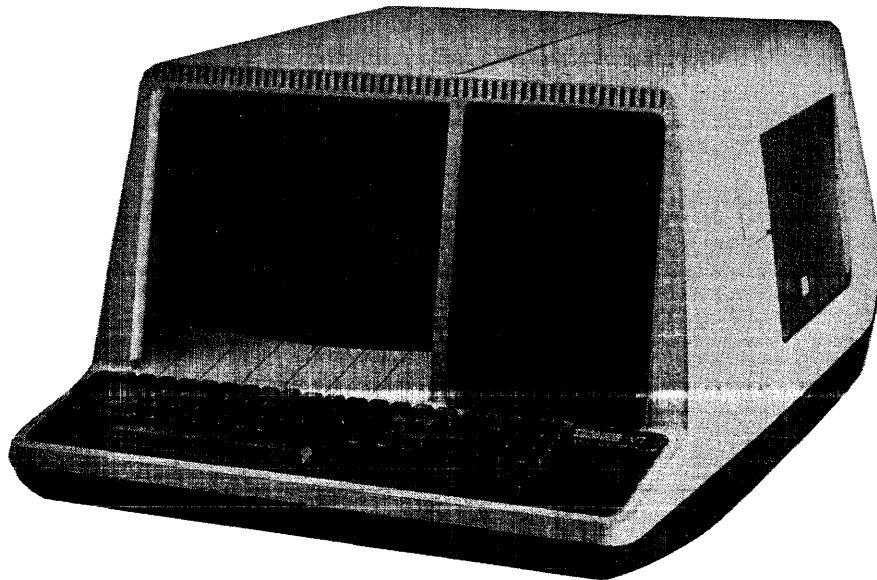
Figure 1   DECstation – Intelligent Terminal or I/O Device Configuration

1
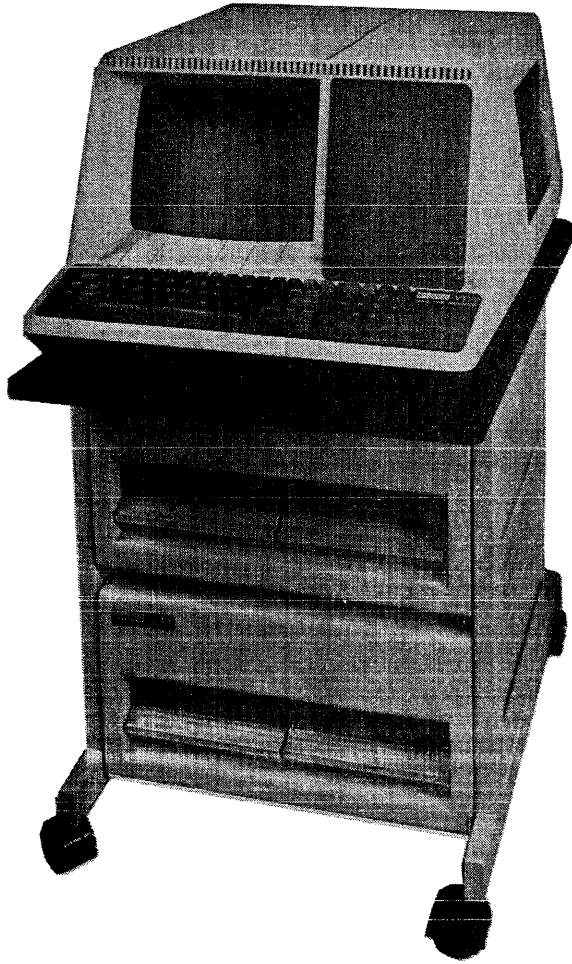
Figure 2 DECstation – Typical Stand-Alone Computer Configuration

OPERATION

If your DECstation is not equipped with a floppy disk drive system, operate the system as shown in Figure 3. If your system has a floppy disk drive system, perform the steps shown in Figure 4.

NOTE
If your DECstation fails to operate properly or the display does not appear as shown in Step 2 (Figures 3 and 4), refer to the troubleshooting procedures.

1. TURN ON SYSTEM (REAR)

START XXXX XXXX AC MQ XXXX XXXX

4. OBSERVE START MESSAGE

ABCDEF

2. OBSERVE DISPLAY
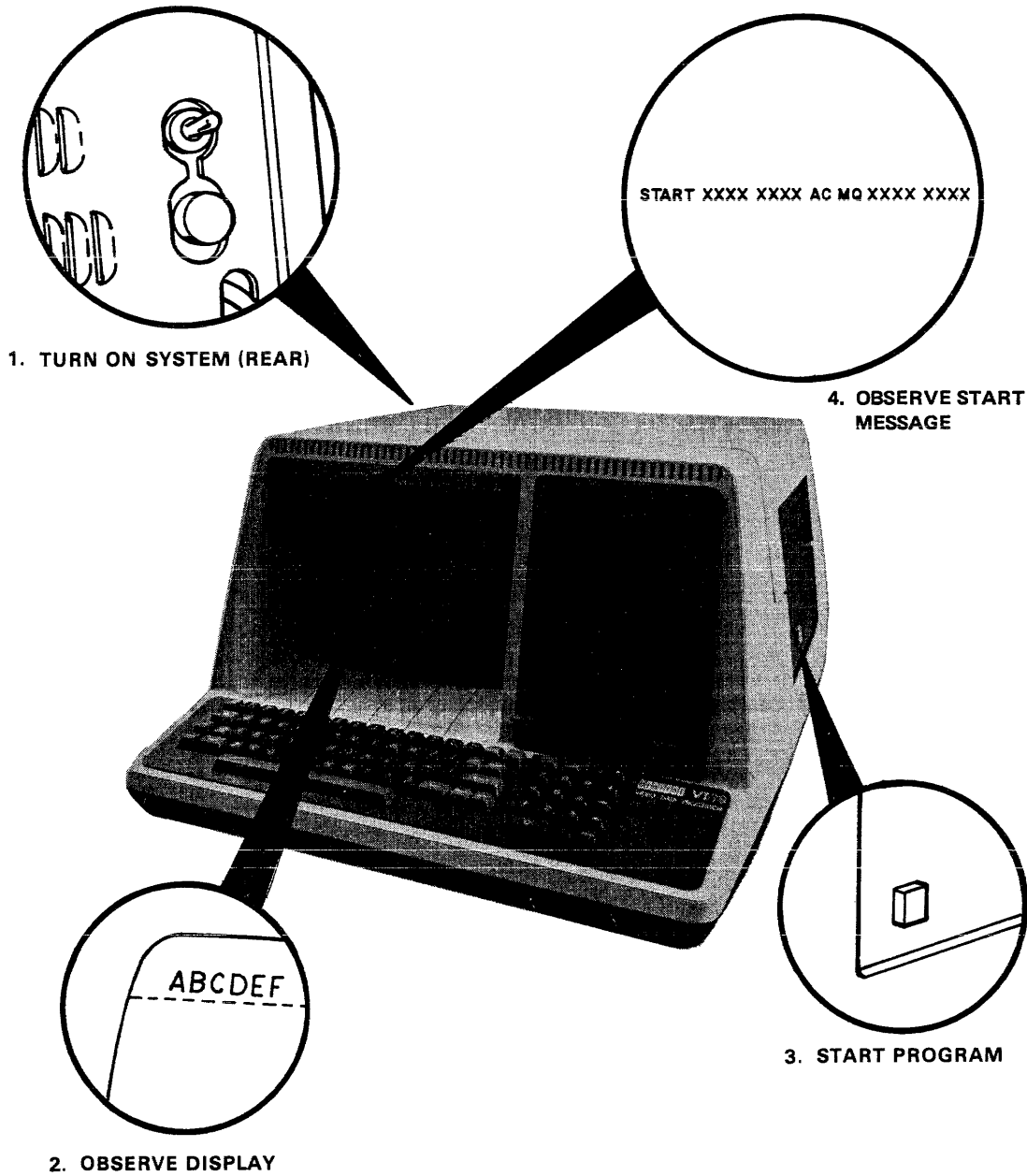
3. START PROGRAM

8587-8

Figure 3   DECstation – Without Floppy Disk Drive System,
Operating Instructions
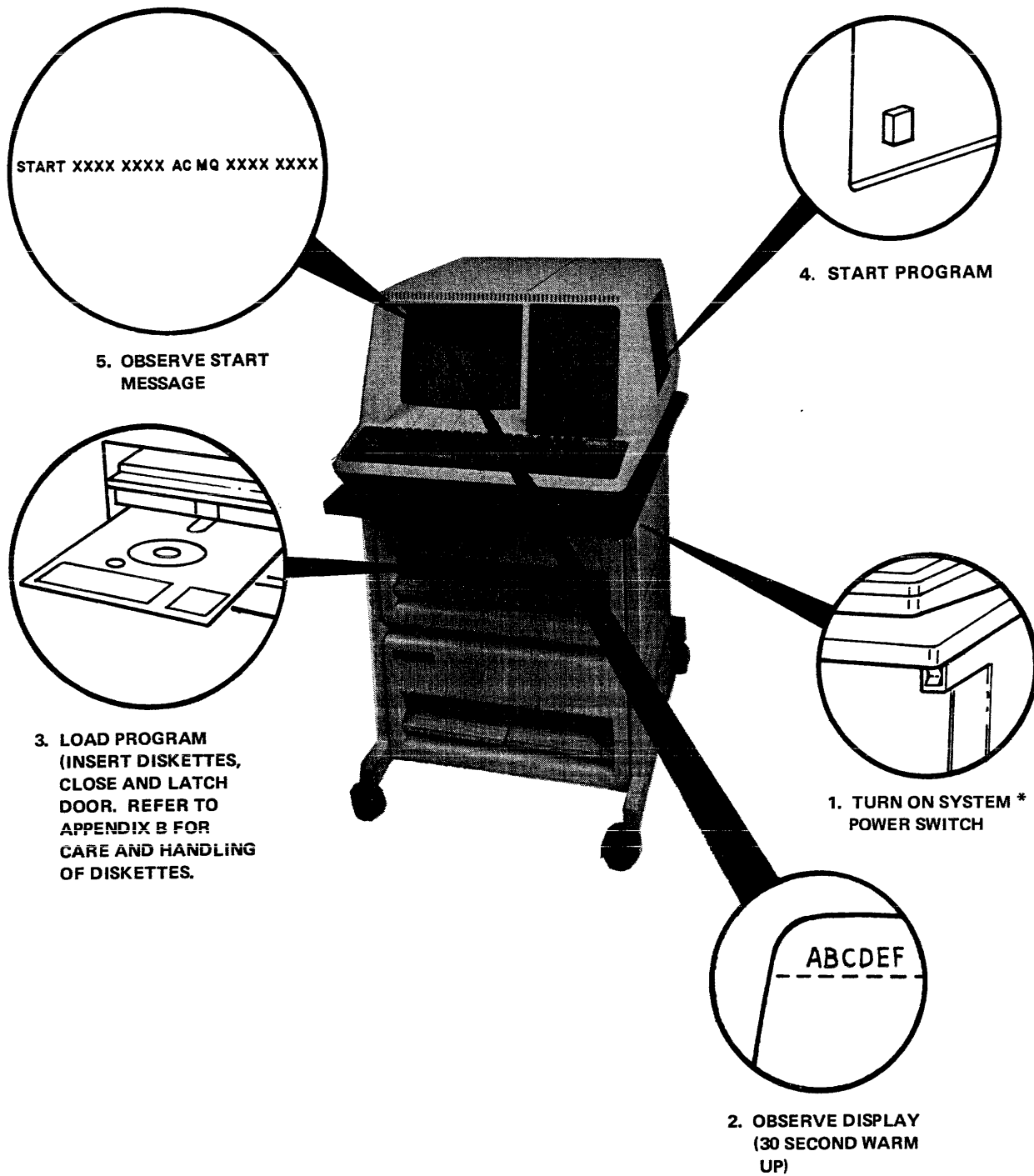
START XXXX XXXX AC MQ XXXX XXXX

5. OBSERVE START
   MESSAGE

4. START PROGRAM
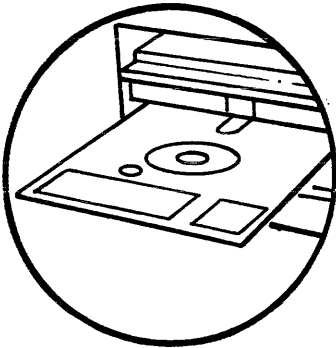
3. LOAD PROGRAM
   (INSERT DISKETTES,
   CLOSE AND LATCH
   DOOR. REFER TO
   APPENDIX B FOR
   CARE AND HANDLING
   OF DISKETTES.
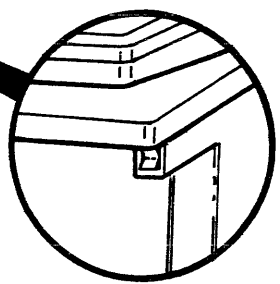
1. TURN ON SYSTEM *
   POWER SWITCH

ABCDEF
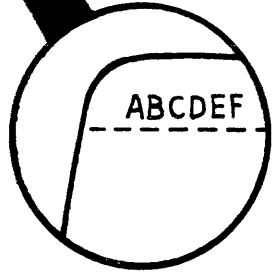
2. OBSERVE DISPLAY
   (30 SECOND WARM
   UP)

*Make sure power switch
 on rear of terminal is set
 to on position.

8587-9

Figure 4   DECstation – With Floppy Disk Drive System,
Operating Instructions

INSTALLATION

All DECstation components are shipped completely assembled. To install and prepare your system for operation, perform the following step-by-step instructions.

☐ **Unpack the system components.**

Be careful to avoid damaging the equipment when using sharp cutting tools to open shipping containers.

☐ **Inspect the equipment.**

Check for any physical damage that may have occurred during shipping and handling.

☐ **Install the MR78 (if your system has one).**

Insert the device into the connector at the rear of the VT78 terminal as shown in Figure 5. Tighten the two screws on the device to secure it in place.
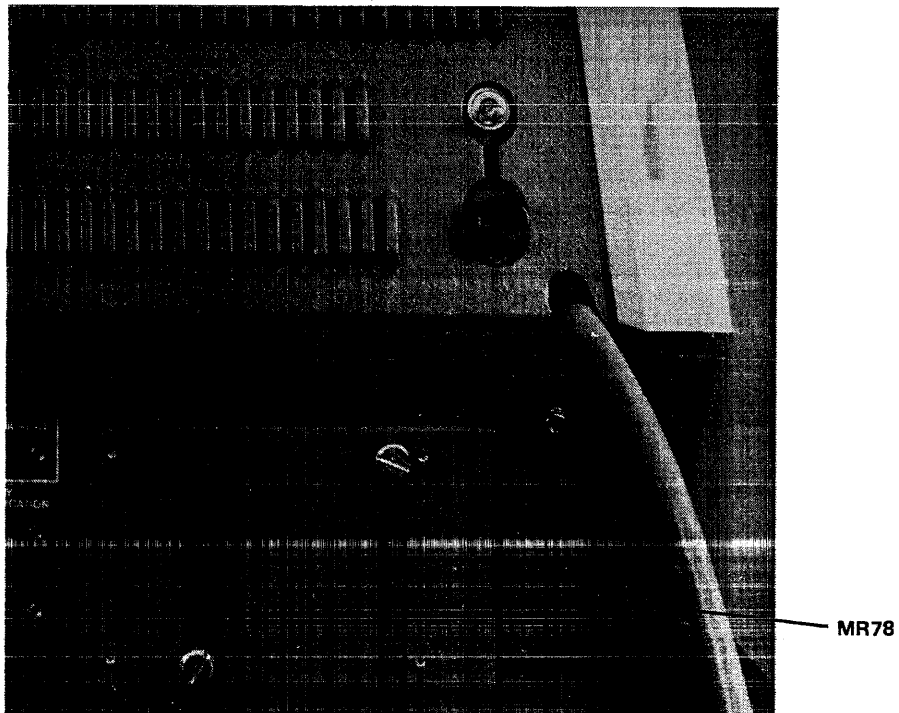
MR78

8587-7

Figure 5   MR78 Installed

☐   **Install the RX78 floppy disk drive(s) (if your system has one).**

CAUTION
The floppy disk drive weighs approximately 29.48 kg
(65 lb). Two people are required to lift the unit to
avoid personal injury or equipment damage.

RX78 FLOPPY
DISK DRIVE
PARTIALLY
INSTALLED

SLIDE

RX78 FLOPPY DISK
DRIVE (INSTALLED)
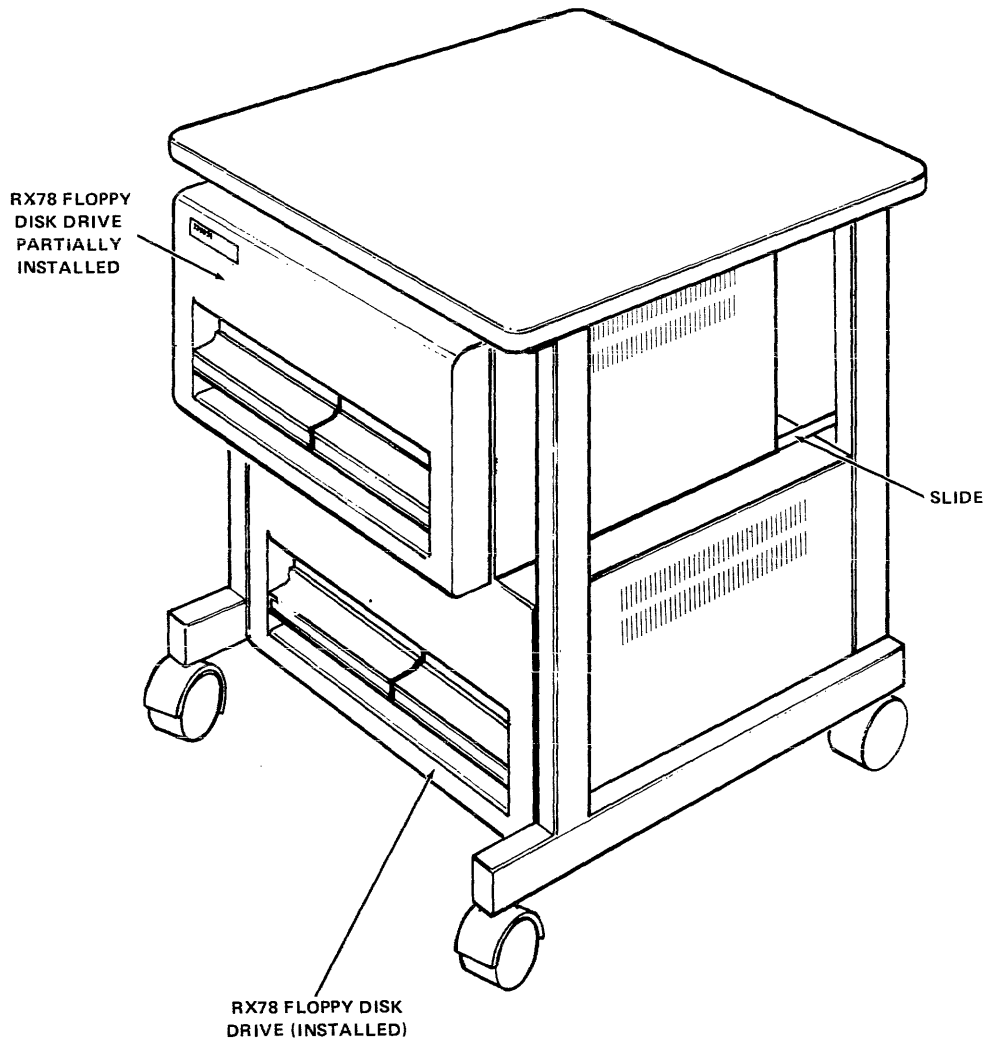
08-1953

Figure 6   Installing the Floppy Disk Drive System

8

Slide the floppy disk drive(s) into the minidesk as shown in Figure 6.

NOTE
It may be necessary to brace the table against the wall when inserting the floppy disk drive system(s) to prevent the table from rolling when sliding the unit forward.

☐ **Set the VT78 terminal on the minidesk.**

☐ **Arrange the DECstation in a convenient operating position.**

NOTE
There are no restrictions limiting the arrangement of the DECstation components except those imposed by the length of the cables and the availability of adequate power outlets. All components can be table-top mounted. Refer to Figure 7 for minimum space requirements and Appendix A for operating and environmental specifications.

☐ **Set the terminal power switch to the OFF (down) position.**

The terminal power switch is located at the rear of the VT78 terminal as shown in Figure 8.

☐ **Set the RX78 floppy disk drive system(s) ON/OFF switch(es) to OFF (if your DECstation has a floppy disk drive system(s).**

The RX78 floppy disk drive system ON/OFF switch is located at the rear of the unit as shown in Figure 9.

☐ **Set the system power switch to OFF (if your system has the minidesk).**

The system power switch is located beneath the front of the minidesk top as shown in Figure 4.

☐ **Plug the terminal power cord into the power outlet.**

If your system is comprised of a terminal and an MR78, as shown in Figure 8, plug the terminal line cord into a convenient power outlet. The DECstation is now ready to operate. Refer to the preceding operation section for operating instructions. (A description of all system controls and indicators is provided in Appendix C.)

If your system is equipped with a minidesk, as shown in Figure 9, plug the terminal into the minidesk power strip.
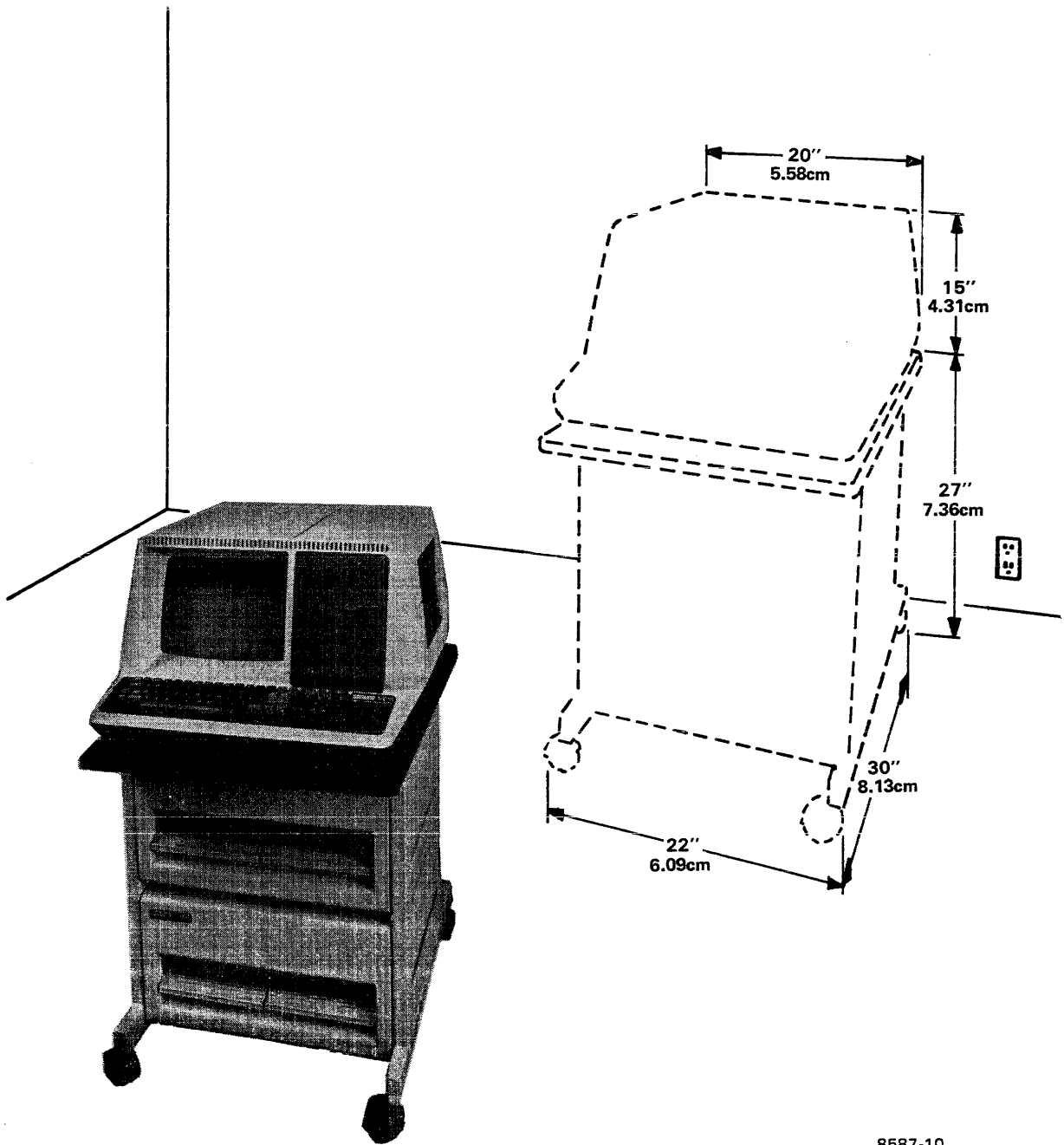
Figure 7   Recommended Minimum Space Requirements

8587-10
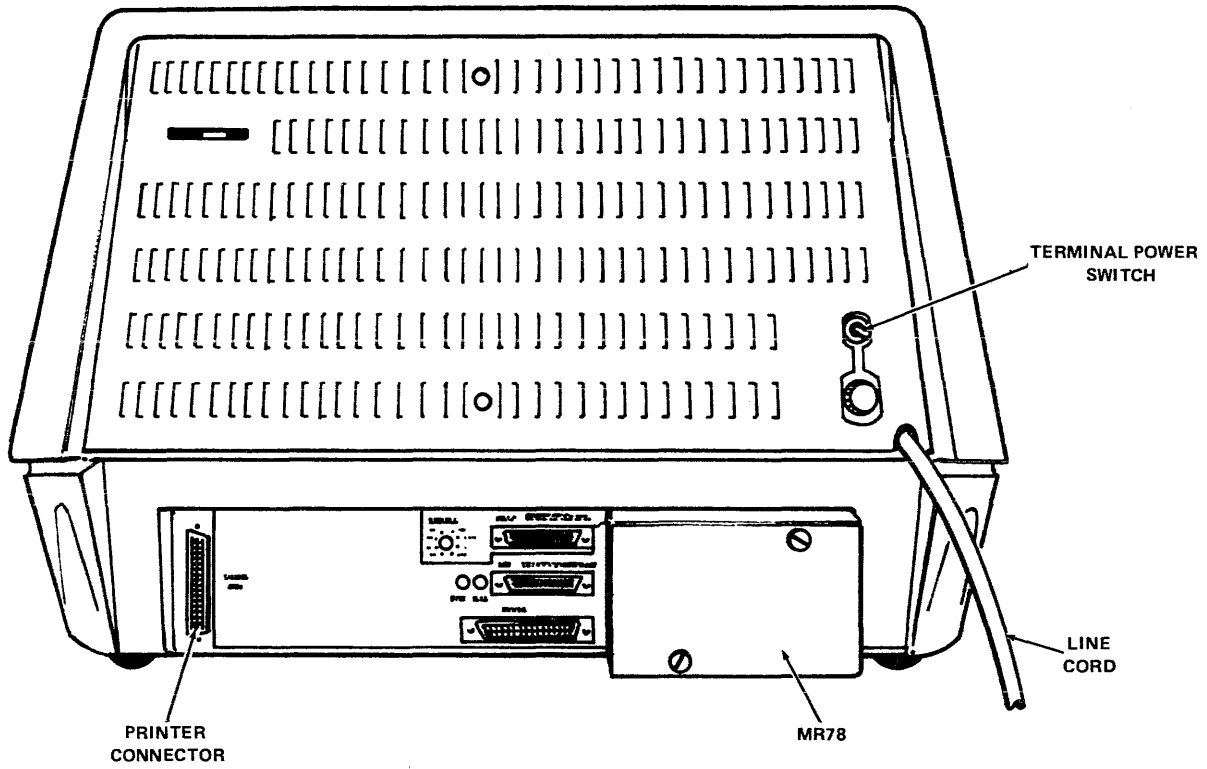
Figure 8   DECstation with MR78 – Cable Connections and Switch Locations

08-1954

11

VT78
TERMINAL

TERMINAL
POWER SWITCH

LA78/LQP
SIGNAL CABLE
PRINTER OPTION
(#BC 80H-25
OR #BC 80F-25)

MR78
(OPTIONAL)

MINIDESK
POWER
STRIP

TERMINAL
LINE CORD

RX78 POWER
CABLE

RX78 FLOPPY
DISK DRIVE
SYSTEM

RX78 ON/
OFF SWITCH

RX78 FLOPPY
DISK DRIVE
SYSTEM/TERMINAL
SIGNAL CABLE
#BC80D
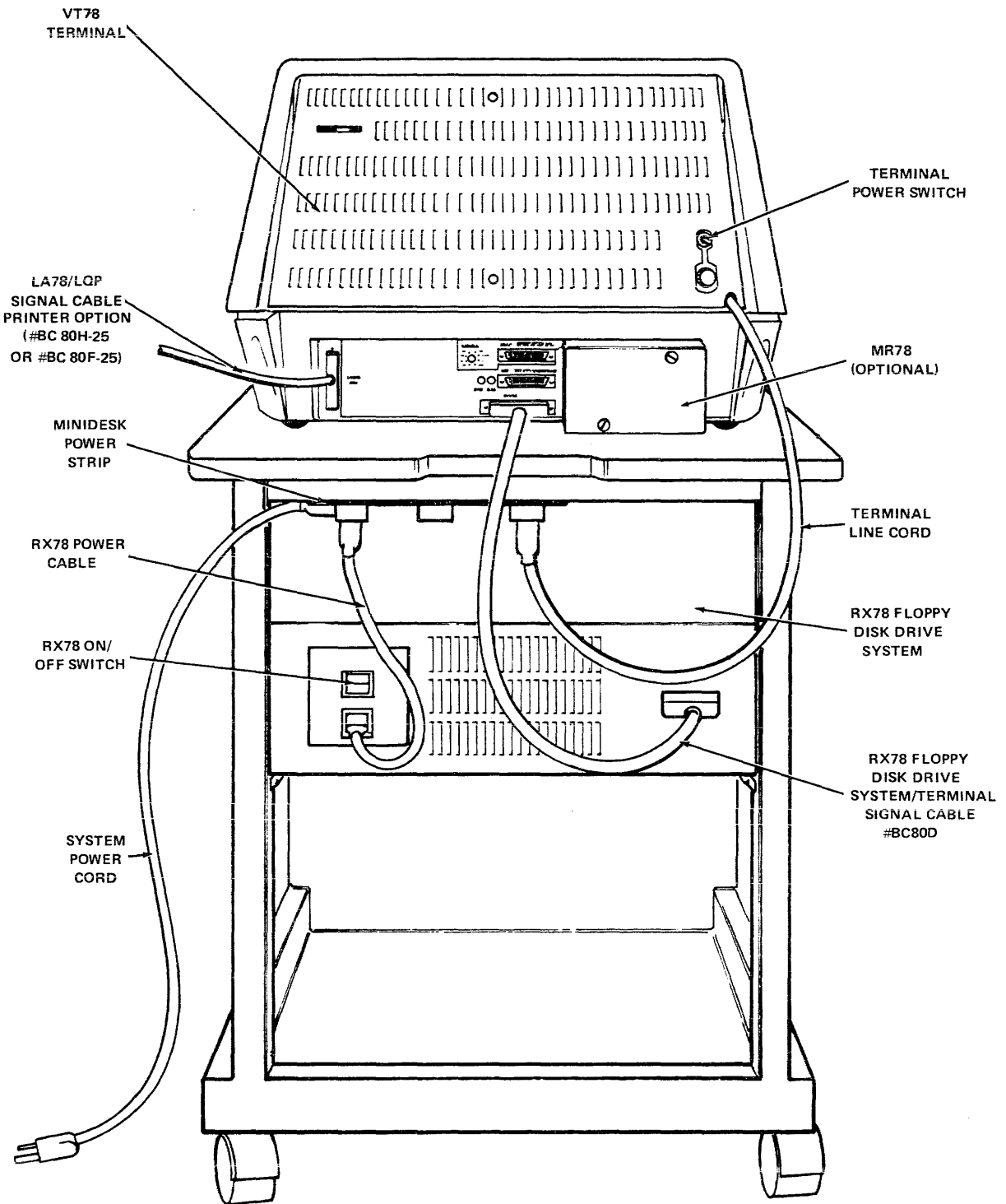
SYSTEM
POWER
CORD

08-1952

Figure 9   DECstation with One Floppy Disk Drive System – Cable Connections
and Switch Locations

12

☐ **Install the upper RX78 floppy disk drive system power cable (if your DECstation has a floppy disk drive system). (Refer to Figure 9.)**

If your system is not installed in the minidesk, insert one end of the cable into the floppy disk drive system, as shown in Figure 9, and plug the other end of the cable into any convenient power outlet.

☐ **Connect the upper RX78 floppy disk drive system/terminal signal cable. (Refer to Figure 9.)**

☐ **Connect the lower RX78 floppy disk drive system power cable (if your DECstation has a second floppy disk drive system). (Refer to Figure 10.)**

If your system is not installed in the minidesk, insert one end of the cable into the floppy disk drive system and the other into any convenient power outlet.

☐ **Connect the lower RX78 floppy disk drive system/terminal signal cable (if your DECstation has a second floppy disk drive system). (Refer to Figure 10.)**

☐ **Plug the system line cord into a convenient wall power outlet (if your DECstation has a minidesk). (Refer to Figure 9 or 10.)**

☐ **Remove the nylon tie-wrap securing the LA78 printer print head (if your DECstation has an LA78 printer).**

☐ **Connect the LA78 printer signal cable to the VT78 terminal (if your DECstation has an LA78 printer). (Refer to Figure 10.)**

☐ **Plug the LA78 printer line cord into a convenient wall power outlet (if your DECstation has an LA78 printer). (Refer to Figure 9 or 10.)**

NOTE
If your DECstation has an LQP78 printer, contact your nearest DIGITAL representative for assistance in installing the printer.

☐ **Set the floppy disk drive ON/OFF switch(es) to ON.**

☐ **Set the VT78 terminal power switch to the ON (up) position.**

Your DECstation is now ready to operate. Refer to the preceding operation section for instructions. (A description of all system controls and indicators is provided in Appendix C.)

VT78
TERMINAL

TERMINAL
POWER SWITCH

LA78/LPQ78
PRINTER OPTION
SIGNAL CABLE
(#BC 80H-25
OR #BC 80F-25)

MR78
(OPTIONAL)

TERMINAL
LINE CORD

MINIDESK
POWER STRIP

RX78 FLOPPY
DISK DRIVE
SYSTEM/TERMINAL
SIGNAL CABLE
#BC80E

RX78 POWER
CABLE

RX78 FLOPPY DISK
DRIVE SYSTEM
(UPPER UNIT)

RX78 ON/OFF
SWITCH

SYSTEM
POWER
CORD

RX78 FLOPPY
DISK DRIVE
SYSTEM
(LOWER UNIT)

RX78 ON/OFF
SWITCH

RX78 POWER
CABLE
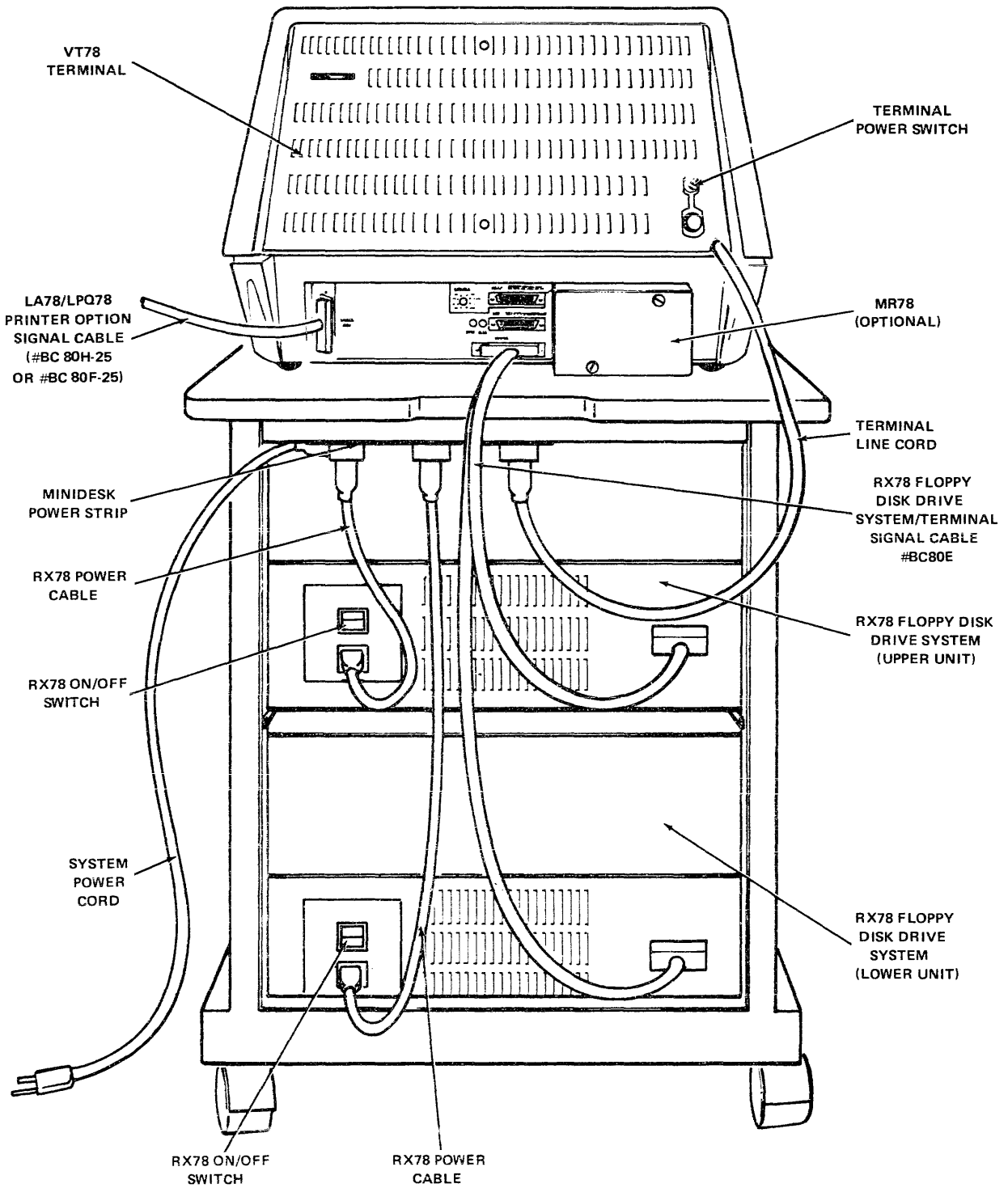
08-1951

Figure 10   DECstation with Two Floppy Disk Drive Systems – Cable Connections
and Switch Locations

14

MAINTENANCE

The keyboard and auxiliary keypad keys are the only moving parts of the DECstation and require no preventive maintenance. The terminal and floppy disk drive (if applicable) can be cleaned with soap or any mild detergent and water. Cleaners with solvents should not be used.

There are several openings in the case through which liquids, coins, paper clips, or other objects could fall, thereby disrupting circuit operation. For this reason, avoid setting drinks and metal objects on top of the terminal or using excessive water to clean the terminal.

The electronics in the keyboard and keypad area are close to the exterior. Rubbing the keys with a dry or barely moist cloth should suffice to clean them. Do not remove the key caps to clean the keys more thoroughly; damage may result to the switch contacts if caps are replaced incorrectly.

TROUBLESHOOTING

Even the most sophisticated and reliable system can malfunction. However, many malfunctions are not equipment malfunctions at all, but are simple problems such as accidently turning down the terminal intensity control or unplugging the line cord.

If your system fails to operate or operates improperly, check the symptoms and possible causes listed in Table 1 before calling your DIGITAL service representative.

NOTE
If problems cannot be corrected using these quick checks, contact your nearest DIGITAL service representative.

Table 1   DECstation Troubleshooting Procedures

Symptom	Possible Cause	Corrective Action
System completely inoperative (no response or sound when power ON/OFF switch is set to ON.	Line cord unplugged.	Plug in the line cord.
	Power receptacle dead.	Check appropriate building fuse or circuit breaker.
	Terminal power switch in the off position.	Set the terminal power switch (rear of terminal) to the on (up) position.
	Blown fuse.	Replace with same type fuse.
System powered up but display does not appear.	Intensity control on rear of terminal turned down.	Adjust intensity control for desired display brightness.
ABCDEF display absent or letter missing.	Circuit malfunction.	Turn the system off, then on again. Check to see if DC OK and CP OK indicators at the rear of the terminal are on. If problem persists call your DIGITAL service representative.

Table 1   DECstation Troubleshooting Procedures (Cont)

Symptom	Possible Cause	Corrective Action
Display correct but program cannot be loaded.	Loose MR78 program loading device (if DECstation is equipped with MR78 device).	Tighten the two screws securing the MR78 to the rear of the terminal.
	If DECstation is equipped with floppy disk drive system(s):	
	a. Floppy disk drive system power ON/OFF switch set to OFF.	Set the floppy disk drive system power ON/OFF switch (rear of unit) to ON.
	b. Diskette inserted improperly into floppy disk drive system.	Reinsert diskette properly.
	c. Defective diskette	Substitute diskette with one known to be good. Try to load program again.
	d. Floppy disk system line cord unplugged.	Plug line cord in power terminal strip at rear of stand (Figure 9 or 10).
	e. Floppy disk drive system/terminal interface cable loose or unplugged.	Check cable connections (Figure 9 or 10).

CENTRAL PROCESSOR UNIT (CPU)

The processor, shown in Figure 11, is comprised of six 12-bit data registers, control logic, timing logic, and an arithmetic logical unit (ALU).

The ALU performs both arithmetic and logical operations such as AND, TAD, and logical OR. ALU operations involve two operands, one held in the accumulator (AC) and the other in a memory location.

The AC is a 12-bit data register used in ALU operations. Data is fetched from memory to the AC or transferred from the AC to memory. The AC can be cleared, complemented, incremented, tested, and rotated under program control.

Link (L) is a 1-bit flip-flop that serves as a high-order extension to the AC (a carry bit).

The program counter (PC) contains the address, in memory, from which the next instruction is fetched. During an instruction fetch, the PC determines the instruction address and is incremented by one. If a branch to another address in memory is requested (i.e., a JMP or JMS instruction), a new address is loaded into the PC. Several operate and IOT instructions will produce a program skip. These instructions cause the PC to be incremented by one a second time, thus skipping the next sequential instruction.

The multiplier quotient (MQ) register is a temporary register used to exchange data, OR data, or store data received from the AC.

A more detailed description of the functional operation of the CPU is provided in the *DECstation Technical Manual*.

MEMORY

There are two types of memory in the VT78 terminal – main memory and panel memory. Main memory (Figure 12) consists of a volatile 16K random access memory (RAM) divided into 4K blocks (fields) of memory. Each field (0–3) contains a 4K 12-bit RAM memory that is used to store a user's main program and data.

Panel memory (Figure 13) uses both read-only memory (ROM) and RAM memories. Panel memory contains 4K of memory addresses. Each address contains 12 bits of data or an instruction. The internal diagnostics, MR78 bootstrap, and disk bootstrap programs are stored in panel memory at addresses 6000 through 7777 (octal). Because these programs need several addresses in which to store register information, two pages of RAM have been provided at location 0000 to 377_8 of this field of memory. Locations 400_8 through 5777 contain no memory.

RESET, RUN/HLT
DMAREQ,CPREQ
INTREQ

DX

MUX

IR

MAJOR
STATE
GEN

PLA

OUTPUT
LATCH

ALU &
TRANS
LOGIC

MEMORY &
DEVICE
CONTROL

SKP, CO, C1, C2

LXMAR, DEVSEL,
SWSEL, MEMSEL
CPSEL

PC

MAR

MQ

AC

ALU

TEMP

LINK

TIMING &
STATE
CONTROL

CRYSTAL

XTA, XTB, XTC, DMAGNT,
INTGNT, IFETCH, DATAF, RUN

WAIT

08-1869
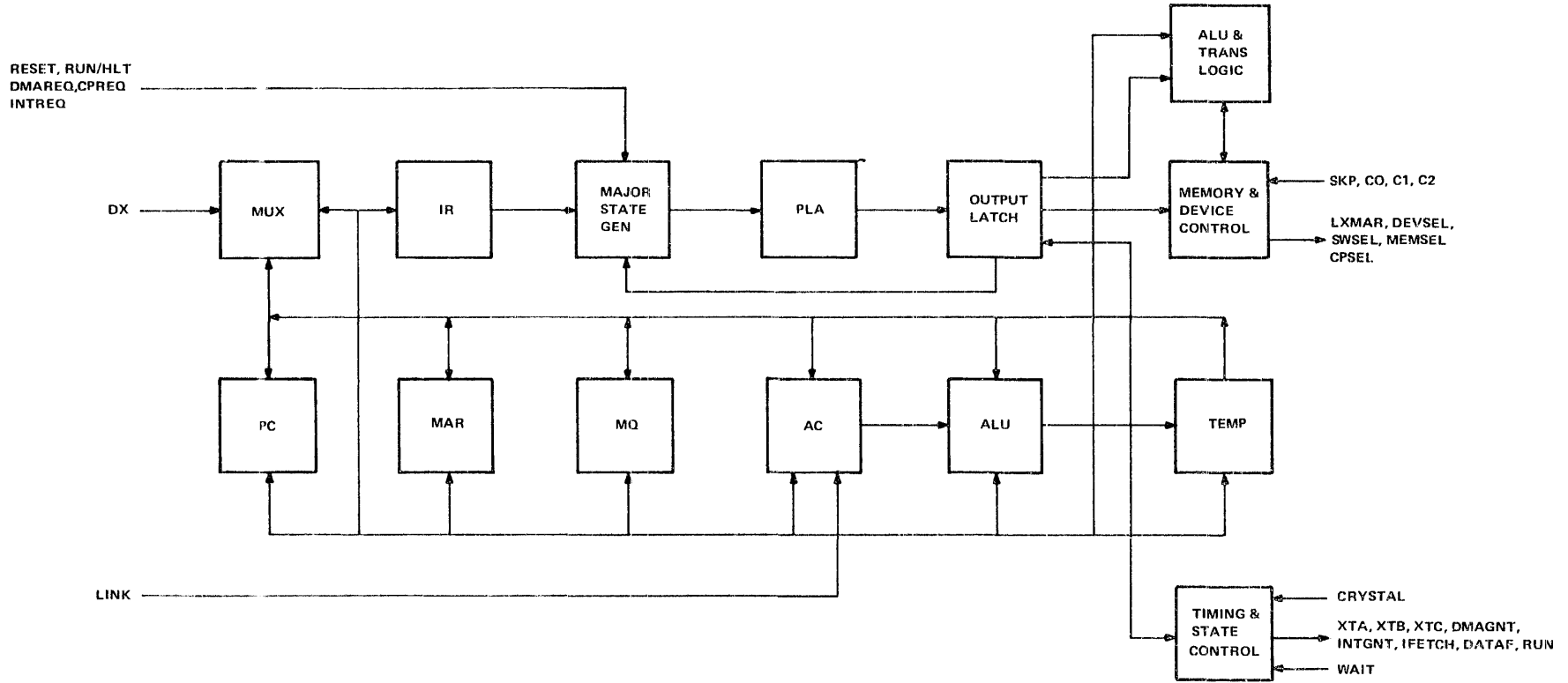
Figure 11   CPU Block Diagram

FIELD 3
FIELD 2
FIELD 1
FIELD 0

[16K(MAX)]

PAGE 37₈
PAGE 36₈

PAGE 7
PAGE 6
PAGE 5
PAGE 4
PAGE 3
PAGE 2
PAGE 1
PAGE 0

[40₈ PAGES]
1 MEMORY FIELD

7777₈

0177₈
0000₈

LOC 177₈
LOC 176₈

LOC 7
LOC 6
LOC 5
LOC 4
LOC 3
LOC 2
LOC 1
LOC 0

[200₈ LOCATIONS]
1 MEMORY PAGE

177₈ = 128₁₀
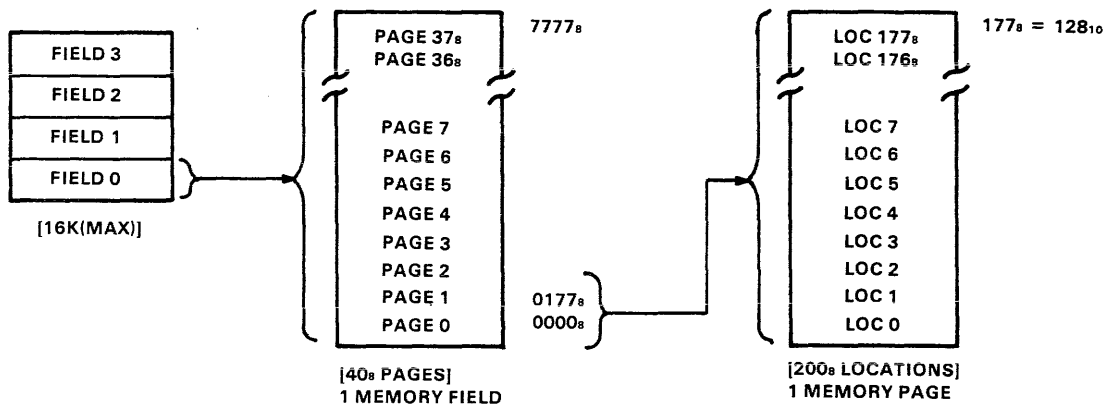
08-1932

Figure 12   Main Memory

PAGE 37₈ [ROM]
PAGE 36₈ [ROM]

PAGE 31ₓ [ROM]
PAGE 30ₓ [ROM]
NO MEMORY

NO MEMORY
PAGE 1 [RAM]
PAGE 0 [RAM]

7777₈

6000₈

0377₈
0177₈
0000₈

LOC 177₈
LOC 176₈

LOC 5
LOC 4
LOC 3
LOC 2
LOC 1
LOC 0

200₈ LOCATIONS
1 MEMORY PAGE

12ₓ PAGES < 10₈ ROM PAGES
              2 RAM PAGES

1 FIELD FOR CONTROL
PANEL MEMORY
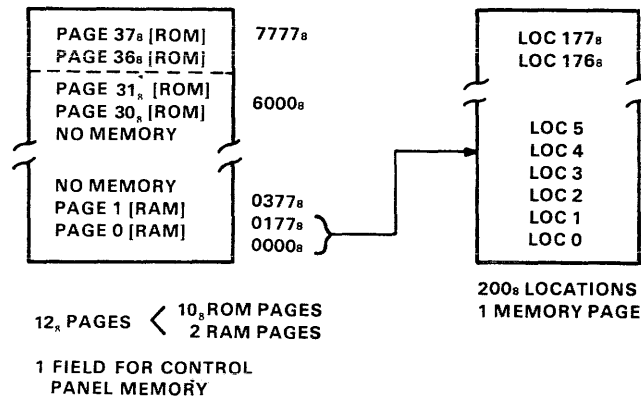
08-1933

Figure 13   Panel Memory

INSTRUCTIONS

Memory Reference Instructions (MRIs)

The MRIs cause the computer to operate on the contents of a memory location or to use the contents of a memory location to operate on the AC.

Figure 14 shows the MRI format. Bits 0 through 2 specify the function (op code) to be executed while the lower order bits, 3 through 11, give the operand address. Table 2 lists the mnemonics for the five MRIs, their octal codes, and the operations performed.

Table 2 MRI Operation Codes

OP Code	Mnemonic	Time (μs)	Operation*	Description
0	AND	5.92 8.8 9.4	D I A	The content of the effective location is ANDed with the contents of the AC. The result is deposited into the AC (link and MQ register are unchanged).
1	TAD	5.92 8.8 9.47	D I A	The contents of the effective location are added to the contents of the AC using 2's complement arithmetic. The result is deposited into the AC. The link bit is set (1); otherwise, link and MQ register are unchanged.
2	ISZ	9.47 12.4 13.0	D I A	The content of the effective location is incremented, then tested for a zero. If the result is zero, the next sequential instruction is skipped; otherwise, the next sequential instruction is fetched. The AC, link, and MQ register are unchanged.
3	DCA	6.5 9.47 10.0	D I A	The contents of the AC are deposited into the effective location. The AC is then cleared. Link and MQ register are unchanged.
4	JMS	6.5 9.47 10.0	D I A	The contents of the PC are stored at the effective location and the effective location, + 1, is loaded into the PC. This is a jump to subroutine instruction (link, AC, and MQ are unchanged).
5	JMP	5.92 8.8 9.47	D I A	The effective address is loaded into the PC (link, AC, and MQ are unchanged).

Note: *D = Direct
      I = Indirect
     A = Autoindexing

00	01	02	03	04	05	06	07	08	09	10	11
			IA	MP							

OP CODE 0-5   PAGE ADDRESS

MEMORY PAGE   0 = PAGE 0
               1 = CURRENT PAGE

INDIRECT   0 = DIRECT
ADDRESSING   1 = INDIRECT
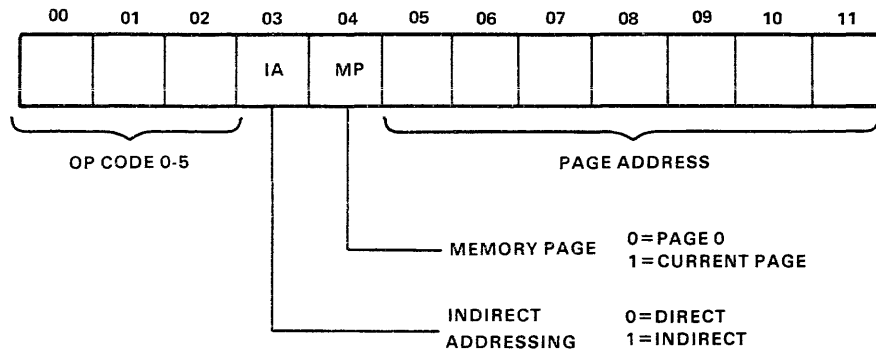
08-1926

Figure 14   MRI Format

Bits 3 through 11 specify an address on one of two pages of memory. The page of memory is determined by bit 4. If bit 4 is a 0, the address specified will be in location 0000 to 0177 of page 0. If bit 4 is a 1, the location will be in the current page (the page on which the instruction is located). Bits 5 through 11 determine the absolute address on the page. For example, if an instruction is located at address 503 and bits 3 through 11 equal 364, the operand address will be in location 164 of the current page or at address 564.

After an address has been determined, the processor examines bit 3 to determine if this address is the operand address (direct addressing) or a pointer to the operand address (indirect or deferred addressing). If bit 3 equals 0, the processor operates on the address specified. If bit 3 equals 1, the processor uses the data from this page address as the 12-bit address of the operand. Notice that although the page addressing method restricts direct addressing to a maximum of 256 locations, indirect addressing allows access to all 4096 locations in the current memory field. For example, if the instruction is located at address 503 and instruction bits 3 through 11 equal 764, and if the contents of location 564 were 3015, the effective address would be 3015.

Autoindexing locations 10-17 are treated in a special manner. If an indirect reference is made through one of these addresses, the address is incremented before being used. No facility for skipping is provided when a location has been incremented to zero. To use autoindexing locations, the memory page (MP) bit must be cleared, even if the instructions are on page zero.

Operate Microinstructions
The operate microinstructions are identified by an op code of 7 (bits 0-2 = 111). Operate instructions do not specify a memory address; instead, the remaining nine bits specify the operation to be performed.

The operate instructions are subdivided into three major classes – Group I, Group II, and Group III – as described in the following paragraphs. Group I microinstructions provide manipulation of the AC and the link. Group II provides testing of the AC and link. Group III allows manipulation of the MQ.

Group I Microinstructions
Figure 15 shows the format of a Group I microinstruction.

23

00	01	02	03	04	05	06	07	08	09	10	11
1	1	1	0	CLA	CLL	CMA	CML	RAR/RTR	RAL/RTL	0/1	IAC

7₈ FOR ALL MICRO INSTRUCTIONS
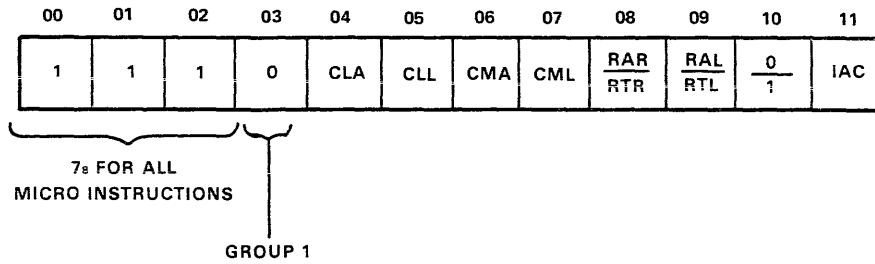
GROUP 1

08-1927

Figure 15   Group I Microinstruction Format

The Group I microinstructions allow the programmer to manipulate the AC and the link bit. The functions cause the AC to be cleared, complemented, incremented, rotated to the left or right one bit, rotated to the left or right two bits, or byte swapped. The link can be cleared, complemented, or shifted right or left with the AC. Any combination of logically nonconflicting bits can be used unless bits 8 and 9 are both set.

Table 3 lists the Group I microinstructions, their assigned mnemonics, and their operations.

Table 3   Group I Microinstructions

Octal	Mnemonic	Sequence*	Times (μs)	Description
7000	NOP	1	5.92	No operation.
7001	IAC	3	5.92	Increment AC by 1. Carry out of AC0 complements link.
7002	BSW	4	8.84	Byte swap. Right six bits are exchanged with left six bits (AC0 exchanged with AC6; AC1 with AC7; etc). Link is not changed.
7004	RAL	4	8.88	Rotate AC left one bit. AC0 rotated into link. Link rotated to AC bit 11.
7006	RTL	4	8.88	Rotate AC left two bits. AC1 rotated into link. Link rotated to AC bit 10.
7010	RAR	4	8.88	Rotate AC right one bit. AC11 rotated into link. Link rotated to AC bit 0.

Table 3 Group I Microinstructions (Cont)

Octal	Mnemonic	Sequence*	Time (μs)	Description
7012	RTR	4	8.88	Rotate AC right two bits AC10 rotated into link. Link rotated to AC bit 1.
7020	CML	2	5.92	Complement link.
7040	CMA	2	5.92	Complement AC.
7041	CIA	2,3	5.92	Complement AC and increment AC. (Forms the 2's complement.)
7100	CLL	1	5.92	Clear link (L=0).
7104	CLL RAL	1,4	8.88	Clear link then rotate AC and link left.
7106	CLL RTL	1,4	8.88	Clear link then rotate AC and link twice left.
7110	CLL RAR	1,4	8.88	Clear link then rotate AC and link right.
7112	CLL RTR	1,4	8.88	Clear link then rotate AC and link twice right.
7120	STL	1,2	5.92	Set the link (clear, then complement link).
7200	CLA	1	5.92	Clear the AC (AC=0000).
7201	CLA IAC	1,3	5.92	Clear the AC then increment the AC (AC=0001).
7204	GLK	1,4	8.88	Get the link (AC is cleared; the AC and link are rotated left).
7240	STA	1,2	5.92	Set the AC (AC=7777).
7300	CLA CLL	1	5.92	Clear the AC and link.

*Logical Sequence

1 = CLA, CLL
2 = CMA, CML
3 = IAC
4 = RAR, RAL, RTR, RTL, BSW

Group II Microinstructions

Group II microinstructions allow the programmer to test the data in the AC and/or the link using the skip instructions. For Group II microinstructions, bit 3 must be a 1 and bit 11 must be a 0. Figure 16 shows the format of a Group II microinstruction.

A skip microinstruction requiring bit 8 to equal zero cannot be programmed with instructions requiring that bit 8 equals a 1.

Table 4 lists the Group II microinstructions, their assigned mnemonics, and their operations.

08-1928
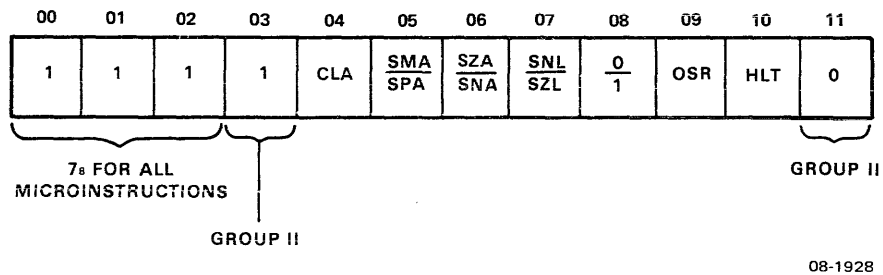
Figure 16   Group II Microinstruction Format

Table 4   Group II Microinstructions

Octal	Mnemonic	Sequence*	Time (μs)	Description
7400	NOP	1	5.92	No operation (See Group I microinstruction).
7402	HLT	4	5.92	HALT – Stops main memory processing. The VT78 displays a series of status words defining the state of the program and waits for the operator to press the START button.
7404	OSR	3	8.88	Clear AC. Load AC with preselect and MR78 status. Bits 8–11 = Preselect Bits 3– 5 = Number of binary program Bit 0 = MR78 is present.
7410	SKP	1	5.92	SKIP (PC is incremented by one, next instruction is skipped).
7420	SNL	1	5.92	Skip on nonzero link.
7430	SZL	1	5.92	Skip on zero link.

26

Table 4 Group II Microinstructions (Cont)

Octal	Mnemonic	Sequence*	Time (μs)	Description
7440	SZA	1	5.92	Skip on zero AC.
7450	SNA	1	5.92	Skip on nonzero AC.
7460	SZA SNL	1	5.92	Skip on zero AC, or skip on nonzero link or both.
7470	SNA SZL	1	5.92	Skip if AC is nonzero and link is zero.
7500	SMA	1	5.92	Skip on minus AC. [If AC(0) = 1, skip.]
7510	SPA	1	5.92	Skip on positive AC. [If AC(0) = 0, skip.]
7520	SMA SNL	1	5.92	Skip on minus AC or skip nonzero link or both.
7530	SPA SZL	1	5.92	Skip if AC is positive and link is zero.
7540	SMA SZA	1	5.92	Skip on minus AC or skip on zero AC or both.
7550	SPA SNA	1	5.92	Skip if AC is positive and nonzero.
7560	SMA SZA SNL	1	5.92	Skip on minus AC or skip on zero AC or skip on nonzero link or all.
7570	SPA SNA SZL	1	5.92	Skip if link is zero and AC is positive and non-zero.
7600	CLA	2	5.92	Clear AC.
7604	LAS	1,3	8.88	OR with preselect and MR78 status. Bits 8–11 = Preselect Bits 3– 5 = Number of binary program Bit 0 = MR78 is present
7640	SZA CLA	1,2	5.92	Skip on zero AC then clear AC.

27

Table 4 Group II Microinstructions (Cont)

Octal	Mnemonic	Sequence*	Time (μs)	Description
7650	SNA CLA	1,2	5.92	Skip on nonzero AC then clear AC.
7700	SMA CLA	1,2	5.92	Skip on minus AC then clear AC.
7710	SPA CLA	1,2	5.92	Skip on positive AC then clear AC.

*Logical Sequence

1 =	When bit 8 is 0 – either SMA, SZA or SNL
	When bit 8 is 1 – Both SPA, SNA and SZL
2 =	CLA
3 =	OSR
4 =	HLT

Group III Microinstructions

Figure 17 shows the format of a Group III microinstruction.

These microinstructions allow the programmer to manipulate the MQ register. Bits 3 and 11 must be set (1) for Group III microinstructions. Although bits 6, 8, 9, and 10 are not used, it is recommended that they always remain 0 so that code generated on this system will be compatible to computers that are equipped with extended arithmetic elements.

Table 5 list the Group III microinstructions, their assigned octal numbers, and their operations.
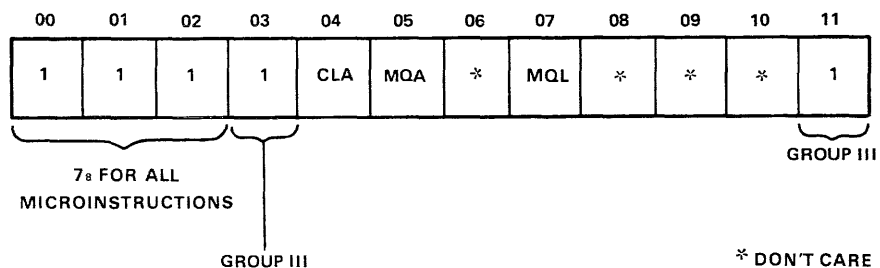
Figure 17 Group III Microinstruction Format

28

Table 5 Group III Microinstructions

Octal	Mnemonic	Sequence*	Time (μs)	Description
7401	NOP	3	5.92	No operation.
7421	MQL	2	5.92	MQ register load. AC is loaded into MQ, AC is then cleared.
7501	MQA	2	5.92	MQ register is loaded into AC. MQ is ORed with AC; results loaded in AC.
7521	SWP	3	5.92	Swap MQ and AC.
7601	CLA	1	5.92	Clear AC.
7621	CAM	3	5.92	Clear AC and clear MQ.
7701	ACL	3	5.92	Clear AC, then load MQ into AC.
7721	CLA SWP	3	5.92	Load MQ into AC, clear MQ.

* Logical Sequence

1 = CLA
2 = MQA, MQL
3 = SWP

I/O TRANSFERS (IOTs)

The I/O instructions (0-2) are identified by op code 6. The control bits (9-11) define the function to be performed. Bits 3-8 represent the device selection code that specifies which device is intended. These six bits will accommodate a maximum of 64 I/O devices. Some of these device codes are used for CPU I/O and memory extensions. All instruction times are 10 μs. Figure 18 shows the complete IOT instruction format.

Extended Memory Instruction IOTs

Memory extension is necessary because the maximum number of memory locations that can be defined by 12 bits is 4096 addresses. The DECstation system uses 16K memory; therefore, an additional two bits are needed to define any addresses above 4K. Memory extension instructions use registers to define the bits of addressing. These registers are the instruction field (IF), data field (DF), instruction buffer (IB), and the save field (SF) registers.

A list of the memory instructions and a brief description of each is provided in Table 6.

The IF is a 2-bit register that serves as an extension to the PC. Instructions and directly addressed operands are obtained from the IF.

```
      00   01   02   03   04   05   06   07   08   09   10   11
    ┌─────────────────────────────────────────────────────────┐
    │  1  │  1  │  0  │    │    │    │    │    │    │    │    │    │
    └─────────────────────────────────────────────────────────┘
      └──────┬──────┘ └──────────────┬──────────────┘ └────┬────┘
         6₈ FOR ALL        DEVICE CODE SELECTION      CONTROL BITS
       IOT INSTRUCTIONS
```
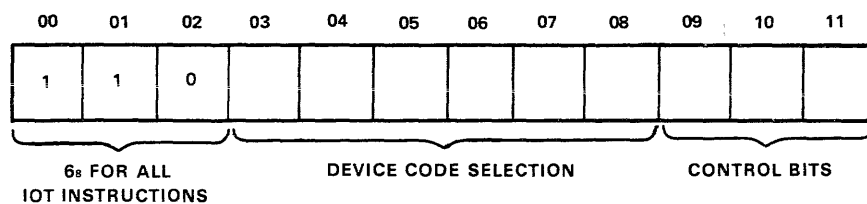
08-1930

Figure 18   IOT Instruction Format

Table 6   Memory Extension Instructions

Octal	Mnemonic	Time (μs)	Description
62N1	CDF	10	Change the data field to N (N may be 0–7).
62N2	CIF	10	At the next JMP or JMS, change instruction field to N. Inhibit interrupts until change occurs (N may be 0–3).
62N3	CDF CIF	10	Combined CDF and CIF.
6214	RDF	10	Read the data field (inclusive OR) into bits 7 and 8 of AC. Note: Bit 6 will always be zero.
6224	RIF	10	Read the instruction field (inclusive OR) into bits 7 and 8 of AC. Bit 6 will always be zero.
6234	RSB	10	Read (inclusive OR) the ISF and DSF into bits 7 and 8 and bits 10–11 of the AC, respectively.
6244	RMF	10	Restore memory fields to their state prior to last interrupt by loading DSF into DF and ISF into IB and inhibiting interrupts. At the time of next JMP or JMS, IB is loaded into IF and the interrupt inhibit is removed.

The IB is a 2-bit register that serves as a holding register whenever a change instruction field (CIF) or equivalent instruction is given. When a CIF instruction is requested, the new field is loaded into the IB and interrupts are inhibited. At the next JMP or JMS, the IB is loaded into the IF and interrupts are allowed. For JMP instructions, the entire instruction cycle takes place in the old field; the new field is not selected until the next instruction fetch. In the case of JMS instructions, the execute phase (depositing the old PC) takes place in the new field. The double buffering of the IF allows the programs to JMS or JMP to any address in the new memory field.

The DF is a 3-bit register that serves as an extension to the memory address register. Indirect AND, TAD, ISZ, and DCA instructions access the current data field.

30

The save field register is a 4-bit register consisting of two halves – the instruction save field (ISF) and the data save field (DSF). Upon recognition of an interrupt, the contents of the IF and DF are loaded into the ISF and DSF, respectively. The IB, IF, and DF are cleared, allowing field 0 to be entered for interrupt handling. The save field is the field in which to return after the interrupt has been processed and the restore memory field (RMF) instruction has been given.

Central Processor Unit IOTs
The central processor IOTs (Table 7) control the interrupt system and panel memory.

If the interrupt system is enabled, the CPU will respond to an interrupt request by storing its PC in location 0, field 0, disabling the interrupt system. The interrupt request line being driven low by any interface will cause an interrupt. The program must then enter a skip chain to determine what I/O device caused the interrupt and proceed to service that device. After servicing, the interrupts can be turned on again.

Table 7   CPU I/O Instructions

Octal	Mnemonic	Time (μs)	Function
6000	SKON	10	Skip if interrupt system is enabled. Turn the interrupt off.
6001	ION	10	If the CPU is in panel mode, exit panel mode after fetching next instruction. If the CPU is fetching from main memory, turn interrupt system on after next instruction fetch.
6002	IOF	10	Turn the interrupt off.
6003	SRQ	10	Skip if interrupt bus is low.
			NOTE **Due to the manner that the memory extension control inhibits interrupts, this IOT will not skip if a CIF has been issued and a JMP or JMS has not been encountered.**
6004	GTF	10	Get Flags Bit 0 = Link Bit Bit 1 = 0 Bit 2 = 1 if interrupt bus (low) Bit 3 = 0 Bit 4 = interrupt enable flip-flop Bit 5 = 0 Bit 6 = 0 Bit 7 = ISF1 Bit 8 = ISF2 Bit 9 = 0 Bit 10 = DSF1 Bit 11 = DSF2

Table 7 CPU I/O Instructions (Cont)

Octal	Mnemonic	Time (μs)	Function
6005	RTF	10	Restore flags. Bit 0 is shifted left into the link, bits 7 and 8 are loaded into IB, bits 10 and 11 are loaded into DF, and interrupts are enabled.
6007	CAF	10	Clear the AC, link, and interrupt. Clear all peripheral flags, and set all interrupt enable flip-flops (except LQP78 if used).
6071	PRS	10	Read panel status into the AC. Then clear panel status. Bit 0 = Power turn on. Bit 1 = START switch. Bit 2 = CPU halted. Bit 3 = IOT 6073 (PRQ) was fetched in main memory.
6072	PST	10	Complement the CPU's run flip-flop.
6073	PRQ	10	Panel request – enter panel mode, set bit 3 of the panel status word. The PRQ processor in panel memory retrieves the word following the PRQ instruction as an address in panel memory and jumps to that address. (Refer to Table 8.)
6074	PER	10	Turn OFF the CPU OK light (used in conjunction with internal diagnostics to indicate condition of CPU – normally on).

Table 8 Panel Request IOTs

Address	Function	Restrictions
6002	Initiates dumb terminal mode (VT78 terminal functions as a conventional terminal, via SLU 2, with a host computer).	
6003	Initiates start routine. Produces same results as pressing terminal START switch.	
6200	Run floppy disk drive bootstrap.	Interrupt must be off.
6201	Run MR78 loader.	Interrupt must be off.

Real Time Clock

The real time clock interrupts the processor every 100 Hz if the interrupt enable is set. A skip instruction causes the program to skip an instruction if the clock flag is set. After testing and skipping on the flag, the programmer must clear the flag.

Table 9 Real-Time Clock Instructions

Mnemonic	Octal Code	Function
CLLE	6135	Load the interrupt enable from the AC 11. If AC 11 = 1, set interrupt enable. If AC 11 = 0, clear interrupt enable.
CLCL	6136	Clear clock flag.
CLSK	6137	Skip on clock flag.

Floppy Disk Drive System

The floppy disk drive system interface allows two modes of data transfer between the VT78 and the floppy disk drive system: 8-bit and 12-bit word lengths. In the 12-bit mode, 64 words are written in a diskette sector, requiring two sectors to store one page of information. The diskette capacity in this mode is 128,128 12-bit words (1,001 pages). In the 8-bit transfer mode, 128 8-bit words are written in each sector. Diskette capacity is 256,256 8-bit words, which is a 33 percent increase in diskette capacity over the 12-bit mode. The 8-bit mode must be used for generating IBM compatible diskettes. Since the 12-bit mode does not fully pack the sectors with data, the hardware puts in extra 0s. Data transfer requests occur 23 μs after the previous request was serviced for 12-bit mode (18 μs for the 8-bit mode). There is no maximum time between the transfer request from the floppy disk drive system and servicing that request by the processor. This allows the data transfer to and from the floppy disk drive system to be interrupted without loss of data.

The floppy disk drive system instruction set is listed in Table 10 and described in the following paragraphs.

Select Command (SEL) – 6750 – This command determines which dual floppy drive will be selected.

Load Command (LCD) – 6751 – This command transfers the contents of the AC to the interface register and clears the AC. If AC bit 4 is zero, the floppy disk drive system begins to execute the function specified in AC 8, 9, and 10 (Figure 19) on the drive specified by AC 7. A new function cannot be initiated unless the floppy disk drive system has completed the previous function.

The function codes (bits 8, 9, and 10) are summarized in Table 11.

The DRV SEL bit (bit 7) selects one of the two floppy disk drive systems to perform the I/O function. When AC 7 = 0, drive 0 is selected. When AC 7 = 1, drive 1 is selected.

The 8- or 12-bit (bit 5) selects the length of the data word. When AC 5 = 0, the 12-bit mode is selected. When AC 5 = 1, the 8-bit mode is selected.

33

Table 10   Floppy Disk Drive System Instruction Set

Octal	Mnemonic	Time (μs)	Function
6750	SEL	10.2	Select RX78 drive pair A if AC 11 = 0 or drive pair B if AC 11 = 1.
6751	LCD	10.2	Load command, clear AC.
6752	XDR	10.2	Transfer DATA register.
6753	STR	10.2	Skip on transfer request.
6754	SER	10.2	Skip on errors.
6755	SDN	10.2	Skip on done.
6756	INTR	10.2	SET/CLEAR interrupt enable with AC 11.
6757	INIT	10.2	Initialize.

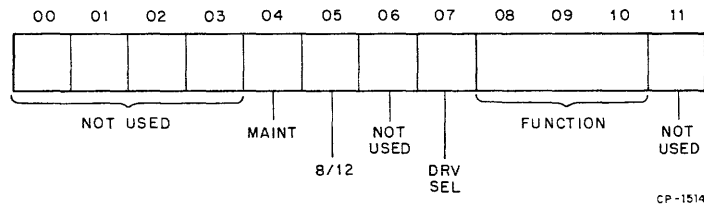
Figure 19   Floppy Disk Drive System Interface I/O Format

Table 11   Floppy Disk Drive System Function Code Bit Summary

Code	Function
000	Fill buffer
001	Empty buffer
010	Write sector
011	Read sector
100	Not used
101	Read status
110	Write deleted data sector
111	Read error register

34

The maintenance bit (bit 4) can be used to diagnose the interface under off-line and on-line conditions. The off-line condition exists when the cable is disconnected from the floppy disk drive system. The on-line condition exists when the cable is connected.

In the on-line mode, if an LCD IOT is issued when AC 4 = 1, the maintenance flip-flop will be set causing assertion of RUN on the following XDR to be inhibited. All data register transfers are then forced into the AC. The maintenance bit allows the interface register to be written and read for maintenance checks. The maintenance flip-flop is cleared by initialize or by an LCD IOT when AC 4 = 0.

In the off-line mode, the contents of the interface buffer cannot be guaranteed immediately following the first LCD IOT, which sets the maintenance flip-flop. However, successive LCD IOTs will guarantee the content of the interface register. The content of the interface register can then be verified by using the XDR IOT to transfer the content into the AC.

The maintenance flip-flop also sets the skip flags, which will remain set as long as the maintenance flip-flop is set. Skipping will not clear the flags as long as the maintenance flip-flop is set. Setting and then clearing the maintenance flip-flop will leave the skip flags in a set condition. The skip IOTs can then be issued to determine whether or not a large portion of the interface skip logic is working correctly.

The maintenance flip-flop can also be used to determine if the interface is capable of generating an interrupt. The maintenance flip-flop is set, thus causing the done flag to set. The interrupt enable flip-flop can be set by issuing an INTR IOT when AC bit 11 = 1. The combination of DONE and interrupt enable should generate an interrupt.

The maintenance flip-flop can be used to test the INIT IOT. This is accomplished by setting the maintenance flip-flop and then clearing it to generate the flags. INIT IOT is then executed. If execution of INIT IOT is successful, all of the flags and the interrupt enable flip-flop should be cleared if previously set.

In the on-line mode, use of the maintenance bit should be restricted to writing and reading the interface register. The same procedure described to write and read the interface register in the off-line mode should be implemented in the on-line mode. Exiting from the on-line maintenance bit mode should be finalized by an initialize to the floppy disk drive system.

Fill Buffer (000) – The fill buffer function is used to load the floppy disk drive system sector buffer from the processor with 64 words in the 12-bit mode or 128 words in the 8-bit mode. This instruction only loads the sector buffer. To complete the transfer to the diskette, the write sector function must be performed. The buffer may also be read back by means of the empty buffer function to verify the data.

Upon decoding the fill buffer function, the floppy disk drive system will set the transfer request (TR) flag signaling a request for the first data word. The TR flag must be tested and cleared by the processor with the skip on transfer request (STR) instruction prior to each successive XDR IOT. The data word can then be transferred to the interface register by means of the XDR IOT. The floppy disk drive system then moves the data word from the interface register to the sector buffer and sets the TR flag as a request for the next data word. This sequence is repeated until the sector buffer has been loaded. After the last word has been loaded into the sector buffer, RXES (parity error and CRC error) is moved to the interface register and the floppy disk drive system sets the done flag to indicate the completion of the function. The processor does not have to count the data transfers. Any XDR command, after done is set, will load the RXES status word into the AC. The sector buffer must be completely loaded before the interface will set the done flip-flop and recognize a new command. An interrupt would now occur if the interrupt enable flip-flop were set.

35

Empty Buffer (001) – This function moves the contents of the sector buffer to the processor. When the empty buffer function is decoded, RXES bits 10 and 11 are cleared, and the TR flag is set with the first data word in the interface register. This TR flag acknowledges the request for a data transfer from the buffer to the processor. The flag must be tested and cleared, then the word can be moved to the AC by an XDR command. The direction of the transfer for an XDR command is controlled by the floppy disk drive system. The TR flag is set again with the next word in the interface register. This sequence is repeated until all of the words have been transferred, thus emptying the sector buffer. The done flag is set after the RXES is moved in the interface register to indicate the end of the function. An interrupt would now occur if the interrupt enable flip-flop were set.

<div align="center">

NOTE
The empty buffer function does not destroy the content of the sector buffer.

</div>

Write Sector (010) – This function transfers the content of the sector buffer track and sector on the diskette into the interface register. Upon decoding this function, the interface clears bits 10 and 11 (parity error and CRC error) of the RXES and sets the TR flag, signifying a request for the sector address. The TR flag must be tested and cleared before the sector address can be loaded into the interface register by means of the XDR command.

The TR flag is set again, signifying a request for the track address. The TR flag must be tested and cleared, then the binary track address may be loaded into the interface register by means of the XDR command.

The floppy disk drive system tests the supplied track address to determine if it is within the allowable limits. If it is not, the RXES is moved to the interface register, the error and done flags are set, and the function is terminated.

If the track address is legal, the floppy disk drive moves the head of the selected drive to the selected track, locates the requested sector, transfers the contents of the sector buffer and a CRC character to that sector, and sets the done flip-flop. Any errors encountered in the seek operation will cause the function to cease, the RXES to be loaded into the interface register, and the error and done flags to be set. If no errors are encountered, the RXES is loaded into the interface register and only the done flag is set.

<div align="center">

NOTE
The write sector function does not destroy the content of the sector buffer.

</div>

Read Sector (011) – This function moves a sector of data from a specified track and sector on the floppy disk to the sector buffer. Upon decoding this function, the RX8E clears RXES bits 5, 10, and 11 (deleted data, parity error, and CRC error, respectively) and sets the TR flag signifying the request for the sector address. The flag must be tested and cleared. The sector address is then loaded into the interface register by means of the XDR command. The TR flag is set again signifying a request for the track address. The flag is tested and cleared by the processor, and the track address is then loaded into the interface register by an XDR command. The legality of the track address is checked by the floppy disk drive system. If illegal, the error and done flags are set when RXES moves to the interface register, and the function is terminated. Otherwise, the floppy disk drive system moves the head to the specified track, locates the specified sector, transfers the data to the sector buffer, and computes and checks CRC for data. If no errors occur, the done flag is set with the RXES in the interface register. If an error occurs anytime during the execution of the function, the function is terminated by setting the error and done flags with RXES in the interface register. A detection of CRC error results in RXES bit 11 being set. If a deleted data mark was encountered at the beginning of the desired data field, RXES bit 5 is set.

Read Status (101) – Upon decoding this function, the floppy disk drive system moves the RXES to the interface register and sets the done flag. The RXES can then be read by the XDR.

NOTE
The average time for this function is 250 ms. Excessive use of this function will result in substantially reduced throughput.

Write Deleted Data Sector (110) – This function is identical to the write data function except that a deleted data mark is written prior to the data field rather than the normal data mark. RXES bit 5 (deleted data) will be set in the interface register upon completion of the function.

Read Error Register Function (111) – The read error register function can be used to retrieve explicit error information upon detection of the error flag. Upon receiving this function, the floppy disk drive system moves an error code to the interface register and sets the done flip-flop. The interface register can then be read via an XDR command and the code interrogated to determine which type of failure occurred.

Refer to Table 12 for a list of the read error register functions.

Table 12   Read Error Register Functions

Octal Code	Error Code Meaning
0010	Drive 0 failed to see home on initialize.
0020	Drive 1 failed to see home on initialize.
0030	Found home when stepping out 10 tracks for INIT.
0040	Tried to access a track greater than 77.
0050	Home was found before desired track was reached.
0060	Self-diagnostic error.
0070	Desired sector could not be found after looking at 52 headers (2 revolutions).
0110	More than 40 μs and no SEP clock seen.
0120	A preamble could not be found.
0130	Preamble found but no I/O mark found within allowable time span.
0140	CRC error on what was thought to be a header.
0150	The header track address of a good header does not compare with the desired track.
0160	Too many tries for an IDAM (identifies header).

Table 12 Read Error Register Functions (Cont)

Octal Code	Error Code Meaning
0170	Data AM not found in allotted time.
0200	CRC error on reading the sector from the disk. No code appears in the ERREG.
0210	All parity errors.

Power Fail – There are no actual function codes associated with power fail. When the floppy disk drive system senses a loss of power, it will unload the head and abort all controller action. All status signals are invalid while power is low.

When the floppy disk drive system senses the return of power, it will remove done and begin a sequence to:

1. Move the drive 1 head position mechanism to track 0.
2. Clear any active bits.
3. Read sector 1 of track 1 of drive 0.
4. Set the RXES initialize done bit, after which done is again asserted.

Transfer Data (XDR) – 6752 – With the maintenance flip-flop cleared, this instruction operates as follows. A word is transferred between the AC and the interface register. The direction of the transfer is governed by the floppy disk drive system OUT L line. The length of the word transferred is determined by the mode selected (8- or 12 bit). When done is negated, executing this instruction indicates to the floppy disk drive system that the last data word supplied by the floppy disk drive system has been accepted by the processor, and the floppy disk drive can proceed; or that the data or address word requested by the floppy disk drive system has been provided by the processor and the floppy disk drive system can proceed.

A data transfer (XDR) from the AC always leaves the AC unchanged. If operation is in the 8-bit mode, AC bits 0–3 are transferred to the interface register but are ignored by the floppy disk drive system. Transfers into the AC are 12-bit jam transfers when in the 12-bit mode. When in the 8-bit mode, the 8-bit word is ORed into AC 4–11, and AC 0–3 remain unchanged. When the floppy disk drive system is done, this instruction can be used to transfer the status word from the interface register to the AC. The selected mode controls this transfer as indicated previously.

Skip On Transfer Request (STR) – 6753 – This instruction causes the next instruction to be skipped if the TR flag has been set by the floppy disk drive system and clears the flag. The TR flag should be tested prior to transferring data or address words with the XDR instruction to ensure the data or address has been received or transferred, or after an LCD instruction to ensure the command is in the interface register. In cases where an XDR follows an LCD, the flag only has to be tested once between the two instructions.

Skip On Error – 6754 – This instruction causes the next instruction to be skipped if the error flag has been set by an error condition in the floppy disk drive system and clears the flag. An error also causes the done flag to be set.

The floppy disk drive system error status register contains the current error and status conditions of the selected drive. This read-only register can be accessed by the read status function (101). The RXES is also available in the interface register upon completion of any function. The RXES is accessed by the XDR instruction. The meaning of the error bits is listed in Table 13.

Table 13   Error Status Register Bit Functions

Bit No.	Description
11	CRC Error – The cyclic redundancy check at the end of the header or data field has indicated an error. The header or data must be considered invalid; it is suggested that the data transfer be retried up to ten times, as most data errors are recoverable.
10	Parity Error – When status bit 10=1, a parity error has been detected on command and address information being transferred to the floppy disk drive system from the interface. Upon detection of a parity error, the current function is terminated, the RXES status word is moved to the interface register, and the error and done flags are set. The function can be retried to determine if the parity error is a soft or hard error. A parity error indication means that there is a problem in the interface cable between the floppy disk drive system and the interface.
9	Initialize Done – This bit indicates completion of the initialize routine. It can be asserted due to floppy disk drive system power failure, system power failure, or programmable or bus initialize. This bit is not available within the RXES from a read status function.
5	Deleted Data (DD) – In the course of reading data, a deleted data mark was detected in the identification field. The data following will be collected and transferred normally, as the deleted data mark has no further significance within the floppy disk drive system. Any alteration of files or actual deletion of data due to this mark must be accomplished by user software. This bit will be set if a successful or unsuccessful write deleted data function is performed.
4	Drive Ready – This bit is asserted if the unit currently selected exists, is properly supplied with power, has a diskette installed properly, has its door closed, and has a diskette up to speed.

Skip On Done – 6755 – This instruction causes the next instruction to be skipped if the done flag has been set by the floppy disk drive indicating the completion of a function or detection of an error condition. If the done flag is set, it is cleared by the SDN instruction. This flag will interrupt if interrupts are enabled.

Interrupt Enable (INTR) – 6756 – This instruction enables interrupts by the done flag if AC 11 = 1. It disables interrupts if AC 11 = 0.

Initialize (INIT) – 6757 – The initialize instruction initializes the floppy disk drive by moving the head position mechanism of drive 1 (if drive 1 is available) to track 0. It reads track 1, sector 1, of drive 0. It zeros the error and status register and sets the done flag upon successful completion of initialize. Up to 1.8 seconds can elapse before the floppy disk drive system returns to the done state.

MR78 Interface

The MR78 interface is available for interfacing the optional MR78 device with the VT78 terminal via the connector on the I/O distribution panel.

The MR78 device, described in detail in the *DECstation Technical Manual*, contains a programmed set of ROMs and is accessed using the IOTs listed in Table 14. Data from the MR78 is in binary paper tape format. The data is checksummed and, if an error is encountered, it will be reported on the display as a HLT with status information. The MR78 interface port does not provide for interrupts.

Table 14   MR78 IOTs

Octal	Mnemonic	Function
6011	RSF	Skip if a character is available.
6016	RRB RFC	OR the character presently at the port into the AC (4-11), clear the character available flag, and obtain a new character. Then set character available flag when next character arrives.

Serial Line Unit 1 (SLU 1)

SLU 1 is hardwired to the keyboard/video display. The IOTs associated with SLU 1 are listed in Table 15.

Table 15   SLU 1 IOTs

Octal	Mnemonic	Time (μs)	Description
6030	KCF	10	Clear the input flag.
6031	KSF	10	Skip if input flag set.
6032	KCC	10	Clear input flag, clear AC.
6034	KRS	10	OR content of input buffer into AC.
6035	KIE	10	Load content of AC(11) into interrupt enable flip-flop.
6036	KRB	10	Load content of input buffer into AC, then clear input flag.
6037	KLB	10	Load content of AC(11) into loopback flip-flop.

NOTE
This IOT is used for internal diagnostics. Setting the loopback flip-flop disconnects all SLUs from their connector and connects the outputs back to the inputs of each SLU including the video terminal SLU 1.

40

Table 15 SLU 1 IOTs (Cont)

Octal	Mnemonic	Time (μs)	Description
6040	SPF	10	Set output flag enable.
6041	TSF	10	Skip if output flag is set and flag enable is set.
6042	TCF	10	Clear output flag enable.
6043	TSB	10	Set the baud rate. (See Table 16.)
6044	TLS	10	Same as 6046.
6045	TSK	10	Skip if SLU 1 interrupt enable is set and the input flag is set; or if the SLU 1 interrupt enable flag is set and output flag enable are both present.
6046	TLS	10	Load the content of AC 4-11 into the SLU transmitter and send the character out over the serial line. Set the output flag enable flip-flop. As soon as the new character is loaded into the transmitter, set the output flag.

Serial Line Unit 2 (SLU 2)

SLU 2 is a full-duplex EIA port with programmable baud rate selection. SLU 2 is different from the other SLUs because it has programmable bit detection, character length, stop bit selection, and parity generation. Error bit detection is accomplished with K1E1 IOT. The remaining programmable options are done with KMD1 IOT. The device input code of SLU 2 is 30, the output code is 31.
The IOTs associated with SLU 2 are listed in Table 17.

Table 16 Baud Rates

AC 8-11	Baud Rate	AC 8-11	Baud Rate
0	50	10	1800
1	75	11	2000
2	110*	12	2400*
3	134.5	13	3600
4	150*	14	4800*
5	300*	15	7200
6	600*	16	9600*
7	1200*	17	19200

*Available preselect switch settings for SLU 2.

41

Table 17   SLU 2 IOTs

Octal	Mnemonic	Description
6300	KCF1	Clear input flag.
6301	KSF1	Skip if input flag is set.
6302	KCC1	Clear input flag, clear AC.
6303	–	–
6304	KRS1	OR contents of input buffer into AC.
6305	KIE1	Load content of AC10 into status enable flip-flop and load contents of AC11 into interrupt enable flip-flop. (See Table 18.)
6306	KRB1	Load contents of input buffer into AC, then clear input flag.
6307	KMD1	Set the operating mode of SLU 2. (See Table 19.)
6310	SPF1	Set output flag enable.
6311	TSF1	Skip if output flag is set and flag enable is set.
6312	TCF1	Clear output flag enable.
6313	TSB1	Set baud rate according to Table 16. Normally, this instruction is preceded by an LAS instruction, which obtains a bit pattern from the rotary switch on the I/O distribution panel.
6314	–	This IOT is the same as 6316 (TLS1).
6315	TSK1	Skip if SLU 2 interupt enable is set and if the input flag is set or if the output flag and output flag enable are both present.
6316	TLS1	Load the contents of AC 4–11 into the SLU transmitter and send the character over the serial EIA line. As soon as a new character is loaded into transmitter set output flag.

Table 18   Loading Contents of AC Into Status
Enable and Interrupt Enable Flip-Flops

AC Bit	Function
AC 10	If AC(10) = 1, during KIE1 IOT, error bits are enabled and four extra bits are read into the AC along with the incoming character. These are:
	AC0 Set if any error exists.
	AC1 Set if parity error has occurred.
	AC2 Set if framing error has occurred. A framing error is caused by an invalid stop bit and usually signifies either a break character has been transmitted or the incoming line is open.
	AC3 Set if overrun error has occurred. An overrun error occurs when a new character arrives before the last one was serviced by the program.

Table 19   Setting SLU 2 Operating Modes

AC Bit	Function
	NOTE If the AC bits defined in this table are set, the associated functions will be performed (SLU 2 only) with the KMD1 IOT.
7	If AC(7) = 0, generate and check parity
	If AC(7) = 1, inhibit parity generation and checking and clear parity error bit.
8	If AC(8) = 0, select 1 stop bit.
	If AC(8) = 1, select 1.5 stop bits for a 5-element character. Select 2.0 stop bits for all other lengths.
9, 10	Select number of elements per character length. 9 10 Elements per character 0 0 5 0 1 6 1 0 7 1 1 8
11	If AC 11 = 0 and AC 7 = 0, generate and check for odd parity. If AC 11 = 1 and AC 7 = 0, generate and check for even parity.

Serial Line Unit 3 (SLU 3)

SLU 3 has a programmable baud rate, but is hardwired for 8-bit words. It has no parity or error detection capabilities and is always operated in the full-duplex mode.

The IOTs associated with SLU 3 are listed in Table 20.

Table 20   SLU 3 IOTs

Octal	Mnemonic	Description
6320	KCF2	Clear input flag.
6321	KSF2	Skip if input flag is set.
6322	KCC2	Clear input flag and clear AC.
6323	–	–
6324	KRS2	OR content of input buffer into AC.
6325	KIE2	Load contents of AC(11) into interrupt enable flip-flop.
6326	KRB2	Load contents of input buffer into AC then clear input flag.
6330	SPF2	Set output flag enable.
6331	TSF2	Skip if output flag is set and flag enable is set.
6332	TCF2	Clear output flag enable.
6333	TSB2	Set baud rate according to Table 16.
6334	–	Same as 6336 (TLS2).
6335	TSK2	Skip if SLU3 interrupt enable is set and the input flag is set or the output flag and output flag enable are both present.
6336	TLS2	Load the contents of AC 4–11 into the SLU transmitter and send the character over the serial EIA line. As soon as a new character can be loaded into the SLU transmitter, set the output flag.

Parallel I/O

The parallel I/O permits 12-bit data to be transferred between the processor accumulator and peripheral devices. It has 12 bidirectional lines. Two device codes are available for this interface – device code 66 and 50. The choice between device codes is made by the logic level present at one pin of the parallel I/O connector. Device code 66 is generally used to generate LA78 printer IOTs. Device code 50 is used for the LQP78 printer. The parallel I/O may also be used as a general-purpose 12-bit parallel I/O port using either set of IOT instructions and the signal line OUT to allow input of externally supplied data.

The parallel I/O IOTs for the LA78 printer and the LQP78 printer are listed and described in Tables 21 and 22, respectively.

Table 21 Parallel IOTs – LA78 Printer

Octal	Mnemonic	Time (μs)	Description
6660	PSSF	10	Set the print flag (AC unchanged).
6661	PSKF	10	Skip on flag (if the character RDY flag is set the next sequential instruction is skipped).
6662	PCLF	10	Clear flag (the character RDY flags are cleared – AC not changed. Status register not affected).
6663	–	10	Not used.
6664	PSTB	10	Load printer buffer. AC (0:11) are transferred to the interface buffer register. Approximately 200 ns later, character strobe is issued. AC is not changed.
6665	PCIE	10	Set or clear interrupt enable* if AC11(0) interrupt enable is cleared. If AC11(1) interrupt enable is set, AC is not changed.
6666	PCLF PSTB	10	Load buffer and clear flags (combination 6664 and 6662).
6667	PRDB	10	Read data. If the OUT line is high, the contents of the previous buffer load (6664 or 6666) are read back into the AC. If OUT is low, a 12-bit word supplied by the external device is loaded into the AC.

*After CAF or power on interrupts are enabled.

Table 22 Parallel IOTs – LQP78 Printer

Octal	Mnemonic	Time (μs)	Description
6500	LQSK	10	Skip on done flag. If any of the following conditions exist, skip the next instruction: the transition from high to low of "character ready," "paper ready," "carriage ready," "printer ready," or the "check" line has taken place since this IOT was last issued.
6501	LQRB	10	Read buffer if the OUT line is high. The contents of the output register are read back into the AC. If the OUT line is low, a 12-bit word supplied by the external device is read into the AC.

Table 22 Parallel IOTs – LQP78 Printer (Cont)

Octal	Mnemonic	Time (μs)	Description
6502	LQMP	10	Move paper. AC (0:11) are sent to the output register and, 200 ns later, a "paper strobe" pulse is issued. The AC and the paper ready flag are cleared.
6503	LQMC	10	Move carriage. AC (0:11) are sent to the output register and, 200 ns later, a "carriage strobe" pulse is issued. The AC and the carriage ready flag are cleared.
6504	LQPC	10	Print a character. AC (0:11) are sent to the output register and, 200 ns later, a "character strobe" is issued. The AC and the character ready flag are cleared.
6505	LQRS	10	Read status and clear done flag. The state of the lines listed below are stored in the AC, then the done flag is cleared. ACO = 1 Printer Ready 1 = Character Ready 2 = Carriage Ready 3 = Paper Ready 4 = 0 5 = 0 6 = Check AC 7 = 0 AC 8 = 0 AC 9 = 0 AC 10 = Lift ribbon AC 11 = Interrupt enable
6506	LQLS	10	Write status and set done. AC (10:11) are sent to the interface to set or clear certain control bits AC 10(1) – Set lift ribbon AC 10(0) – Clears lift ribbon AC 11(1) – Sets interrupt enable* AC 11(0) – Clears interrupt enable.
6507	LQRE	10	Restore and clear done flag. Restore strobe is issued for approximately 200 ns. The done flag is cleared. AC is not affected.

*After CAF and power up, interrupts are disabled.

KEYBOARD/VIDEO DISPLAY

The keyboard/video display (Figure 20) enables the user to communicate with the processor and control all of the system peripheral devices.
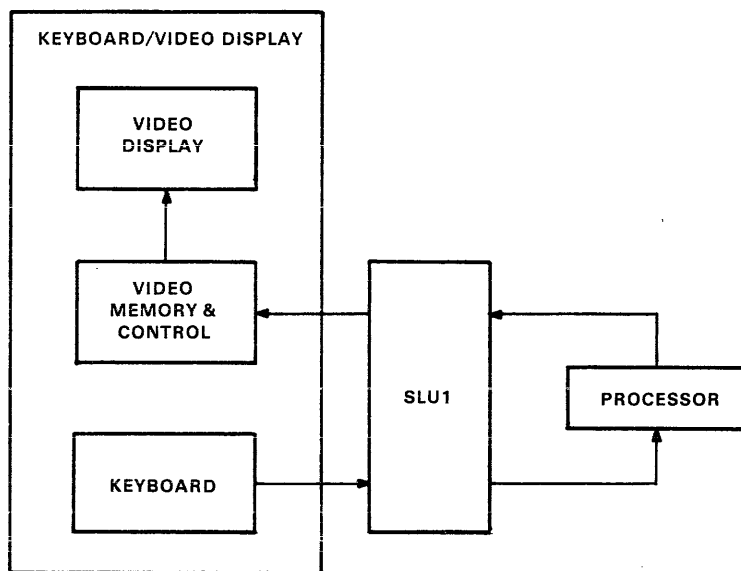
08-1931

Figure 20   Keyboard/Video Display Block Diagram

The keyboard/video display features full-duplex operation with 8-bit ASCII characters. These characters are transmitted or received as serial data coded with a start bit, eight data bits, and a stop bit.

The keyboard/video display is hard-wired to SLU 1 (part of the processor), which provides the interface between the keyboard/video display and the processor.

Keyboard

The keyboard transmits codes to the processor using a set of I/O transfer instructions (device code 03). Some keyboard keys transmit one or more codes to the processor when typed. Others, such as the shift key, are control keys and send no codes.

The code transmitting keys cause the keyboard/video display to make a clicking sound to verify that a keystroke has been sent to the processor. The code is transmitted in the order that the keys are pressed. If three keys are pressed simultaneously, the first two key codes will be transmitted immediately but the third will not be transmitted until the first two keys are released.

All alphabetic keys transmit in uppercase and lowercase code. Uppercase is transmitted when a key is typed while the SHIFT or the CAPS LOCK key is down. (The CAPS LOCK key does not affect codes transmitted by keys other than the alphabetic keys). The uppercase and lowercase key codes are listed in Table 23.

The numeric and symbol key codes are listed in Table 24.

47

Table 23　Alphabetic Key Codes

Key	Uppercase Code*	Lowercase Code*
A	101	141
B	102	142
C	103	143
D	104	144
E	105	145
F	106	146
G	107	147
H	110	150
I	111	151
J	112	152
K	113	153
L	114	154
M	115	155
N	116	156
O	117	157
P	120	160
Q	121	161
R	122	162
S	123	163
T	124	164
U	125	165
V	126	166
W	127	167
X	130	170
Y	131	171
Z	132	172

*All codes are expressed in octal. Note that there are no 8s or 9s in the octal system.

Table 24　Numeric/Symbol Key Codes

Key	Neither SHIFT Key Down	Either or Both SHIFT Keys Down
1	061	041 (!)
2	062	100 (@)
3	063	043 (#)
4	064	044 ($)
5	065	045 (%)
6	066	136 (∧)
7	067	046 (&)
8	070	052 (*)
9	071	050 (()
0	060	051 ())
-	055	137 (__)
=	075	053 (+)
[	133	135 (])
;	073	072 (:)
'	047	042 (")
,	054	074 (<)
.	056	076 (>)
/	057	077 (?)

48

The function keys transmit control codes to the processor. They cause an action to occur in the keyboard/video display such as tab, line feed, etc., if the processor echos these codes back to the keyboard/video display.

The CTRL key is used in conjunction with other keys on the keyboard to produce control codes in the range of 000–037. When held down it alters the code normally produced by a typed key by forcing the two high-order bits of the code to zero. Table 25 lists the codes transmitted when the control key is held down. The original code is included for comparison.

Table 25   Control Key Codes

| Code Originally Transmitted | With The CTRL Key Down | |
	Code Actually Transmitted	Special Name
040 or 100 or 140	000	NUL
041 or 101 or 141	001	SOH
042 or 102 or 142	002	STX
043 or 103 or 143	003	ETX
044 or 104 or 144	004	EOT
045 or 105 or 145	005	ENQ
046 or 106 or 146	006	ACK
047 or 107 or 147	007	BELL
050 or 110 or 150	010	BS
051 or 111 or 151	011	HT
052 or 112 or 152	012	LF
053 or 113 or 153	013	VT
054 or 114 or 154	014	FF
055 or 115 or 155	015	CR
056 or 116 or 156	016	SO
057 or 117 or 157	017	SI
060 or 120 or 160	020	DLE
061 or 121 or 161	021	DC1 or XON
062 or 122 or 162	022	DC2
063 or 123 or 163	023	DC3 or XOFF
064 or 124 or 164	024	DC4
065 or 125 or 165	025	NAK
066 or 126 or 166	026	SYN
067 or 127 or 167	027	ETB
070 or 130 or 170	030	CAN
071 or 131 or 171	031	EM
072 or 132 or 172	032	SUB
073 or 133 or 173	033	ESC
074 or 134 or 174	034	FS
075 or 135 or 175	035	GS
076 or 136 or 176	036	RS
077 or 137 or 177	037	US

The ESC key is used to select a command rather than the characters noted on the character keys. For example, if the keyboard/video display receives code 102, it will display a B on the video screen. If it receives 033, or the ESC key is pressed when the letter B is typed, the code preceding 102 will initiate a command rather than display the character. The letter B will not be displayed on the video screen. If a control code is sent to the keyboard/video display between the ESC and the final character, the function specified by the control code will be performed when the control code is received. The function specified by the escape sequence will be performed when the final character is received.

If the keyboard/video display receives ESC ESC from the processor, the second ESC will not cancel the escape sequence, but will continue to be ready to interrupt the next character in the escape sequence.

Typing the BREAK key forces the serial data output line of the keyboard/video display to the zero state for as long as the key is held down. The BREAK function is provided for users with software written to operate in the half-duplex mode. The keyboard/video display normally operates in the full-duplex mode so there is usually no need for the BREAK function.

The 19-key auxiliary keypad is provided for applications requiring heavy use of the numeric keys. In addition to the 10 numeric keys, the keypad has a decimal point key, four cursor move keys, three blank keys, and an ENTER key.

In the normal mode of operation, the decimal point key and the numeric keys transmit the same code as the decimal point key and the numeric keys on the main keyboard. The processor cannot distinguish between them. The ENTER key transmits the same code as the RETURN key.

In response to a command from the processor, the keyboard/video display will enter the alternate-keypad mode and the ENTER, decimal point, and numeric keys will each transmit a unique escape sequence. This allows the processor to distinguish between main keyboard entries and auxiliary keypad entries. It also provides the processor with 12 user-definable keys to use for individual applications. Table 26 lists the codes transmitted by these keys.

Table 26   Keypad Numeric Key Codes

| Key | Code(s) Transmitted To Processor | |
	Key Not in Alternate-Keypad Mode	Alternate-Keypad Mode
0	060	030 077 160 (ESC ? p)
1	061	033 077 161 (ESC ? q)
2	062	033 077 162 (ESC ? r)
3	063	033 077 163 (ESC ? s)
4	064	033 077 164 (ESC ? t)
5	065	033 077 165 (ESC ? u)
6	066	033 077 166 (ESC ? v)
7	067	033 077 167 (ESC ? w)
8	070	033 077 170 (ESC ? x)
9	071	033 077 171 (ESC ? y)
.	056	033 077 156 (ESC ? n)
ENTER	015	033 077 115 (ESC ? M)

Note: None of the keys on the auxiliary keypad are affected by pressing the SHIFT, CAPS LOCK, or CTRL keys.

The seven remaining keys on the keypad are the four cursor move keys and three blank keys. The cursor move keys transmit an escape sequence to the processor. If the processor echos these codes back to the keyboard/video display, the cursor will move one character position up, down, left, or right, depending on the typed key. The three blank keys transmit user-defined escape sequences. The user can define the meaning of each key to fit a particular application. Table 27 lists the codes transmitted by these seven keys.

Table 27   Keypad Control Key Codes

Keypad Key	Code(s) Transmitted to Processor
Left blank key	033 120 (ESC P)
Center blank key	033 121 (ESC Q)
Right blank key	033 122 (ESC R)
Up-arrow key	033 101 (ESC A)
Down-arrow key	033 102 (ESC B)
Right-arrow key	033 103 (ESC C)
Left-arrow key	033 104 (ESC D)

None of the keys on the auxiliary keypad are affected by pressing the SHIFT, CAPS LOCK, or CTRL keys.

The REPEAT key is used in conjunction with other keys. It does not transmit a code. Any key that transmits a code to the processor will transmit that code repeatedly if pressed while the REPEAT key is down.

The SCROLL key also performs a local function. It is used to request more data from the processor when the keyboard/video display is in the hold screen mode. Typing SCROLL will add one line of characters to the display screen. Typing SHIFT SCROLL will add a screenful of characters.

The COPY key is employed only when using the optional copier peripheral device.

Table 28 lists the function keys, their code, and the keyboard/video display action taken if the code is echoed back to the keyboard/video display.

Display
The display portion of the keyboard/video display has no programmable features. Refer to the *DEC-station Technical Manual* for a detailed functional desception of the display portion of the keyboard/video display.

Basic Cursor Movement Commands

Line Feed (LF – 012) – The LF command moves the cursor down one character position to the same column of the line below. If the cursor was on the bottom line of the screen to begin with, it will remain where it was, but all of the information on the screen will move up one line. The information previously on the top line will be lost from the screen and a new bottom line will appear. This process is referred to as an upward scroll.

Table 28 Function Key Codes

Key	Code Sent	Action
RETURN	015	Carriage Return function.
LINE FEED	012	Line Feed function.
BACK SPACE	010	Backspace (Cursor Left) function.
TAB	011	Tab function.
Space bar	040	Deposit a space on the screen, erasing what was there before.
DELETE	177	Nothing.
ESC (SEL)	033	Interpret the next character from the processor as a command, rather than displaying it.

Cursor Down (ESC B - 033 102) – This command moves the cursor in the same manner as the LF command. If the cursor was on the bottom line of the screen to begin with, it will remain where it was, and no scroll will occur.

Reverse Line Feed (ESC 1 - 033 111) – The reverse line feed command moves the cursor up one character position to the same column of the line above. If the cursor was on the top line to begin with, it will remain where it was, but all of the information on the screen will move down one line. The information that was previously on the bottom line of the screen will be lost and a new blank line will appear at the top line. This process is referred to as a downward scroll.

Cursor Up (ESC A - 033 101) – The cursor up command moves the cursor up one character position to the same column of the line above. If the cursor was on the top line to begin with, it will remain where it was, and no scroll will occur.

Space (040) – The space command erases the character at the cursor position and the cursor moves one column to the right. If the cursor was at the end of the line to begin with, it will not move.

Space can be viewed as a command to erase one character or simply as a displayable character.

Programs written for teleprinters that position the carriage (or cursor) by returning it to the left of the line and spacing it over to the desired column may have to be rewritten. The cursor right command should be used instead of space to move the cursor to a certain column, over data that has already been written on the screen.

Cursor Right (ESC C - 033 103) – This command causes the cursor to move one column to the right. If the cursor was at the end of the line to begin with, it will not move. No character on the screen will be erased.

Cursor Left or Backspace (BS 010) or (ESC D – 033 104) – This command moves the cursor one column to the left. If the cursor was at the start of the line to begin with, it will not move. No character on the screen will be erased.

NOTE
Even though the keyboard/video display responds to the backspace code it is impossible to produce a composite character on the screen by backspacing and overprinting one character on another. If this is attempted, the overprinted character will vanish from the screen because only one character can occupy a character position at any time.

Advanced Cursor Movement Commands

Carriage Return (CR 015) – The carriage return command moves the cursor to the start (leftmost column) of the line it was in. If it was there to begin with, it will remain there.

Cursor Home (ESC H – 033 110) – This command moves the cursor to the home position (the character position at the upper left corner of the screen). If the cursor was there to begin with, it will remain there.

TAB (TAB 011) – The tab command moves the cursor to the right until it reaches a horizontal tab stop. The cursor remains in the same line it was in. If columns are numbered from 1 (leftmost column) to 80 (rightmost column), the TAB stops will be fixed in columns 9, 17, 25, 33, 41, 49, 57, 65, and 73. If the cursor was at a tab stop to begin with, it will move right to the next tab stop. If the cursor was in columns 73-79, it will move right one column. If the cursor was in column 80, it will not move.

Direct Cursor Addressing (ESC Y – 033 131) – The next code after ESC Y that the processor sends to the keyboard/video display will not be displayed but will be interpreted as specifying one of the lines on the screen. The character the keyboard/video display receives after that will not be displayed but will be interpreted as specifying one of the columns on the screen. The cursor will be moved to the character position at the specified line and column. The complete direct cursor addressing command has the form ESC Y line # column # and consists of four characters from the processor. Control codes or other escape sequences should not be embedded in this string of four characters. Doing so will produce unspecified results.

For line #, the processor sends octal code 040 to specify the top line of the screen, 041 to specify the line below the top line, and so forth. Octal code 067 specifies the bottom line. If line # does not specify a line that exists on the screen, the keyboard/video display will not move the cursor vertically if the vertical parameter is out of bounds. A direct cursor addressing command with the first parameter greater than 067 can be issued to the keyboard/video display to move the cursor arbitrarily in the horizontal direction without the flickering of the video that the direct cursor addressing command can cause.

For column #, the processor sends octal code 040 to specify the leftmost column in a line and 157 to specify the rightmost column. If column # is greater than 157 and does not specify a column that exists on the screen, the cursor will be moved to the rightmost column.

Screen Erasure Commands

Erase To End-Of-Line ((ESC K – 033 113) – This command erases all of the information at the cursor position and rightward to the end of the line. Spaces are deposited at those character positions. If the cursor is at the rightmost column of a line, the character at the cursor position will be the only character to be erased. If the cursor is at the leftmost column of a line, the entire line will be erased.

53

Erase To End-Of-Screen (ESC J – 033 112) – This command erases all of the information from the cursor position to the end of the screen. The erase to end-of-screen command does what the erase to end-of-line command does and also erases the information in every line below the cursor. If the cursor is at the lower right corner of the screen, one character will be erased. If the cursor is at the home position of the screen, all of the information on the screen will be erased.

In addition to the screen erasure commands, the space command can be thought of as a single-character screen erasure command.

Hold-Screen Mode of Operation
The hold-screen mode of operation allows the operator to control the rate at which data enters and leaves the screen. This is important because the keyboard/video display can operate at such fast speeds that data from the processor might remain on the screen for only a few seconds before it scrolls up and off the top of the screen to make way for new data.

Whenever the keyboard/video display cannot process data from the processor, it automatically transmits control code XOFF (023). When it is ready again it transmits XON (021). The keyboard/video display depends on the processor to suspend its transmission promptly when the processor receives XOFF from the keyboard/video display and resumes transmission where it left off upon receiving XON. When software places the keyboard/video display in the hold-screen mode of operation, the keyboard/video display will refuse to perform scrolls. If the processor commands the display to scroll by sending the keyboard/video display a LF (012) when the cursor is on the bottom line, the keyboard/video display will place the LF in a silo (first in, first out memory) to be executed later, and send XOFF to the processor. XOFF means the keyboard/video display is not ready for more data from the processor because the keyboard/video display assumes that the operator is not ready for more.

The SCROLL key is pressed when the operator wants to see more data. The keyboard/video display then processes the LF character out of the silo. When this happens a scroll occurs. The keyboard/video display then takes any other characters from the silo that may have arrived from the processor before the processor responded to the XOFF and suspended its output. Each character in the silo is displayed on the screen or, in the case of commands, executed exactly as if it had just been received – unless it is another LF causing another scroll. If the keyboard/video display encounters an LF in the silo, it will stop processing characters out of the silo until the operator types the SCROLL key again.

If the keyboard/video display processes all the characters in the silo without finding an LF, it will transmit XON to the processor to notify it that the keyboard/video display is again ready to receive characters. It will display all the characters and execute all the commands until it is again ordered to perform a scroll. Then it will send XOFF, store the LF in the silo, and wait for the operator to press the SCROLL key again.

If the processor ignores the XOFF signal, it might completely fill the silo. Then, rather than allow data to be lost, the keyboard/video display will perform the scroll it was commanded to perform despite the hold-screen mode. It will remove the characters from the silo and interpret them, reducing the backlog. However, the keyboard/video display will not exit hold-screen mode.

The SCROLL key is typed to request that another line be admitted to the screen. The keyboard/video display translates this request into start and stop commands (XON and XOFF) and sends them to the processor in such a manner that just enough data comes to the keyboard/video display to satisfy the operator's request for one more line.

The operator can type the SCROLL key with the SHIFT key down to request a new screenful of data. As with the unshifted SCROLL request, the keyboard/video display begins to process characters again and sends XON to the processor when the characters that accumulated in the silo have all been processed. But the shifted scroll request tells the keyboard/video display to allow an entire screenful of new data to enter the screen before shutting off the transmission from the processor.

Enter Hold-Screen Mode (ESC – 033 133) – When the keyboard/video display enters hold-screen mode, data will not be allowed to scroll off the screen without permission from the operator by use of the SCROLL key. After entering the hold-screen mode, the first command that would cause a scroll to occur will not be processed immediately, and the keyboard/video display will send XOFF to the processor.

The hold-screen mode will remain in effect until the exit hold-screen mode command disables that feature.

Exit Hold-Screen Mode (ESC / – 033 134) – When the keyboard/video display exits the hold-screen mode, data will be allowed to scroll off the screen if it has to to make room for new data coming from the processor.

Alternate-Keypad Mode Of Operation
The auxiliary keypad is capable of transmitting the codes listed in Table 26. There are two sets of codes that the software can select by issuing these commands – enter alternate-keypad mode and exit alternate-keypad mode.

Alternate-Keypad Mode (ESC = – 033 075) – The alternate-keypad mode enables the numeric keys, decimal point key, and ENTER key to transmit unique escape sequences, allowing software to distinguish between them and keys on the main keyboard, and to assign its own meaning to each key.

The alternate-keypad mode will not be in effect until the processor issues this command. Once enabled, it will remain in effect until the processor uses the exit alternate-keypad mode instruction.

Exit Alternate-Keypad Mode (ESC) – 033 076) – When the exit alternate-keypad mode is initiated the numeral, decimal point, and ENTER keys transmit codes are indistinguishable from the codes transmitted by the numeric, decimal point, and RETURN keys on the main keyboard. Applications that do not need to redefine the meanings of these twelve keys will work correctly allowing the operator to use the keypad for entry of numeric data.

Graphics Mode Of Operation
There are 33 special symbols that can be displayed on the screen of the keyboard/video display. These symbols can be entered on the screen only by placing the keyboard/video display in the graphics mode. Normally, codes 136–176 stand for lowercase letters and symbols. In the graphics mode, each code in this range will specify that one of the special symbols be placed on the screen. Table 29 describes the appearance of the keyboard/video display special symbols that are displayed on the screen in the graphics mode.

Codes 040–135 are unaffected. The symbols represented can be placed on the screen whether or not the keyboard/video display is in the graphics mode.

The keyboard/video display uses the control codes to mark the position of the special symbols in its memory. Therefore, the special symbols and the lowercase letters can coexist on the screen. The special symbols will remain on the screen where they were entered even if the keyboard/video display is taken out of the graphics mode.

Enter Graphics Mode (ESC F – 033 106) – This command causes codes 136–176 to be converted to special symbols before being placed on the screen. This remains true until the keyboard/video display receives the exit graphics mode command.

Exit Graphics Mode (ESC G – 033 107) – The exit graphics mode signal causes codes 136–176 to resume their standard (ASCII) meanings.

Table 29 Graphic Mode Symbols

When This Code Received	The Screen Will Display	
	In Graphics Mode	Not In Graphics Mode
136	blank	$\wedge$
137	blank	—
140	reserved	'
141	solid rectangle	a
142	1/	b
143	3/	c
144	5/	d
145	7/	e
146	degrees	f
147	plus or minus	g
150	right arrow	h
151	ellipsis	i
152	divide by	j
153	down arrow	k
154	bar at scan 0	l
155	bar at scan 1	m
156	bar at scan 2	n
157	bar at scan 3	o
160	bar at scan 4	p
161	bar at scan 5	q
162	bar at scan 6	r
163	bar at scan 7	s
164	subscript 0	t
165	subscript 1	u
166	subscript 2	v
167	subscript 3	w
170	subscript 4	x
171	subscript 5	y
172	subscript 6	z
173	subscript 7	(
174	subscript 8		
175	subscript 9	)
176	paragraph	~

Uses of Special Symbols

Codes 154–163 – These codes cause eight horizontal lines at various scans within the character positon to be displayed. These bars can be used to print a bargraph on the screen with more accuracy than would be possible using only minus signs and underlines.

Codes 142–154 – (1/, 3/, 5/, and 7/) are used preceding the subscripts to form fractions. In particular, the fractions 1/8, 1/4, 3/8, 1/2, 5/8, 3/4, and 7/8 can be formed using these four symbols and the subscripts.

Code 151 – The ellipsis appears as three dots in the character position (...). The spacing of these three dots is such that several of these symbols placed adjacent to one another in the screen will produce a smooth line of dots.

Codes 136–140 – These codes are reserved for future use.

56

OPERATING AND ENVIRONMENTAL SPECIFICATIONS

DECstation with MR78

Operating Environment:

Temperature	10–40° C (50° – 104° F)
Relative humidity	10 to 90 percent
Maximum wet bulb	28° C (82° F)
Minimum dew point	2° C (36° F)

Line voltage	95–127 V or 190–254 V
Line frequency	47–63 Hz

DECstation with RX78 Floppy Disk Drive System

Operating environment:

Temperature	10–32° C (59° – 90° F)
Relative humidity	20 to 80 percent
Maximum wet bulb	25° C (77° F)
Minimum dew point	2° C (36° F)

Line Voltage	95–127 V or 190–254 V
Line Frequency	50 ± 1 Hz or 60 ± 1 Hz

APPENDIX B
CARE AND HANDLING OF DISKETTES

To prolong the diskette life and prevent errors when recording or reading, reasonable care should be taken when handling the diskette. The following handling recommendations should be followed to prevent unnecessary loss of data or interruptions of system operation.

1. Do not write on the envelope containing the diskette. Write any information on a label prior to affixing it to the diskette.

2. Paper clips should not be used on the diskette.

3. Do not use writing instruments that leave flakes, such as lead or grease pencils, on the jacket of diskette.

4. Do not touch the disk surface exposed in the diskette slot or index hole.

5. Do not attempt to clean the diskette in any manner.

6. Keep the diskette away from magnets or tools that may have become magnetized. Any disk exposed to a magnetic field may lose information.

7. Do not expose the diskette to a heat source or sunlight.

8. Always return the diskette to the envelope supplied with it to protect the disk from dust and dirt. Diskettes not being used should be stored in the file box if possible.

9. When the diskette is in use, protect the empty envelope from liquids, dust, and metallic materials.

10. Do not place heavy items on the diskette.

11. Do not store diskettes on top of computer cabinets or places where dirt can be blown by fans into the diskette interior.

12. If a diskette has been exposed to temperatures outside of the operating range, allow five minutes for thermal stabilization before use. The diskette should be removed from its envelope during this time.

13. Store diskettes horizontally, in piles of ten or less. If vertical storage is necessary, the diskettes should be supported so that they do not lean or sag, but should not be subjected to compressive forces. Permanent deformation may result from improper storage.

14. Diskettes should be stored in their original shipping containers when not in use.

APPENDIX C
CONTROLS AND INDICATORS

This appendix contains a list of the DECstation operator's controls and indicators.

NOTE
There are no floppy disk operator's controls or indicators.

VT78 Terminal
All of the VT78 terminal operator controls, with the exception of the terminal ON/OFF and START switches, are located on the keyboard. The terminal ON/OFF switch is located at the rear of the terminal. The START switch is located on the terminal's side.

The keyboard (Figure C-1) is divided into two functional sections – the main keyboard and the auxiliary keypad. The main keyboard is arranged in the same manner as a conventional typewriter keyboard to select uppercase and lowercase alphabetic characters, numerals, and symbols. Table C-1 lists all of the keyboard controls and includes a brief functional description of each.
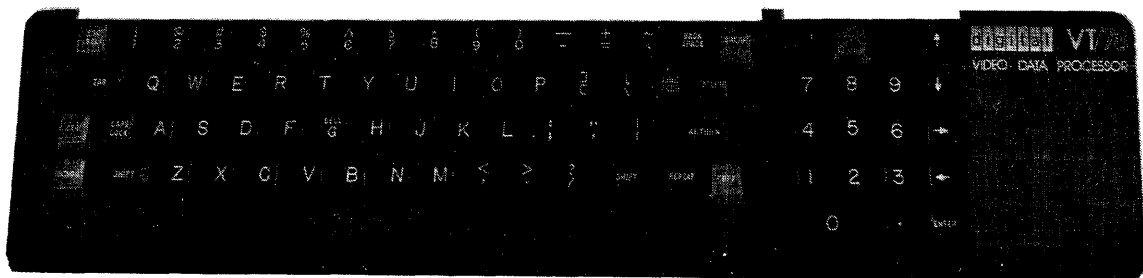

Figure C-1   VT78 Terminal Keyboard

## Table C-1 VT78 Terminal Keyboard
Controls and Indicators

Key	Function
A through Z	Selects corresponding character (uppercase or lowercase depending on position of SHIFT key) to be entered into the processor.
1 through 0 and symbol keys (!, @, #, etc.)	Selects corresponding numeral or symbol (depending on position of SHIFT key) to be entered into the processor.
ESC(SEL)	Interprets next character received from processor as a command.
TAB	Advances cursor to preselected tab stops.
CTRL	Used in conjunction with other keys on the keyboard to generate control codes.
SCROLL	Used to request more lines when terminal is in hold screen mode of operation. Also used in conjunction with SHIFT key to view another screenful of information.
CAPS LOCK	Causes the letters A–Z to always be uppercase characters. (CAPS LOCK does not have any effect on numeral or symbol keys).
SHIFT	Selects uppercase or lowercase alphabetic characters and numeral or symbol characters to be entered into the processor.
BACK SPACE	Moves cursor back one space.
LINE FEED	Drops the cursor one line (does not return the carriage to left margin).
DELETE	Eliminates character above cursor.
RETURN	Moves cursor to extreme left margin.
REPEAT	Used in conjunction with other keys to repeat transmission of character selected.
COPY	Not used.
Intensity (of terminal)	Adjusts intensity of CRT display.

The auxiliary keypad is employed for applications requiring heavy use of number keys. It also contains several cursor control keys. Table C-2 lists all of the auxiliary keys and their functions.

A more detailed description of the main keyboard and auxiliary keypad keys and the codes transmitted when each key is pressed can be found in the programming section.

The VT78 terminal also contains controls used to select baud rates, parity, etc. These controls are not operator controls and are set during system installation.

**Table C-2 VT78 Terminal Auxiliary Keypad
Controls and Indicators**

Key	Function
0-9	Selects corresponding numeral to be entered into the processor and displayed on the video screen.
	Decimal point.
ENTER	Can function as the RETURN key or, in alternate-keypad mode, to transmit unique escape sequences.
$\leftarrow\uparrow\downarrow\rightarrow$	Moves cursor one character position up, down, left, or right.
Blank keys	User-defined escape sequence application keys.

LA78 Printer

The controls used to operate the LA78 printer are shown in Figure C-2. A brief functional description of each is listed in Table C-3. Refer to the *LA180 Maintenance Manual* for a description of the paper loading and adjustment controls.

Table C-3 LA78 Operator Controls and Indicators

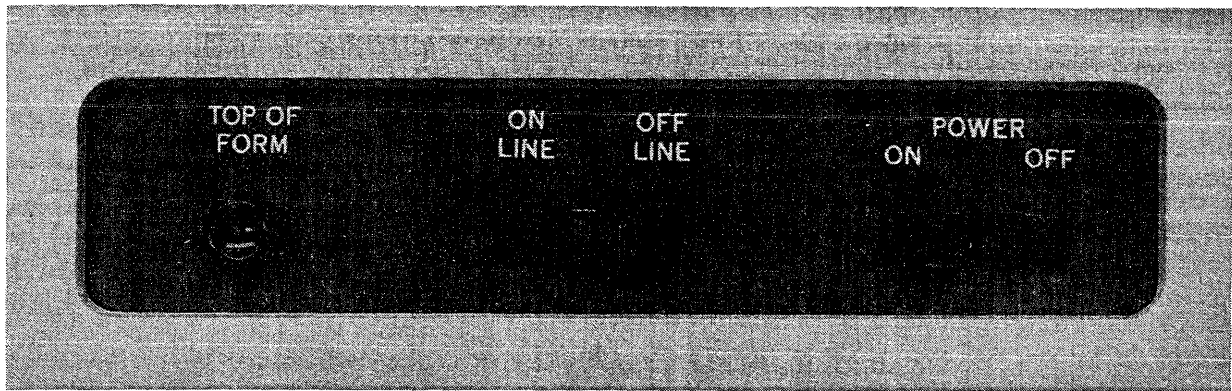| Control	Function
TOP OF FORM	Advances the paper to the top of the form. Only active when the ON LINE/OFF LINE switch is in the OFF LINE position.
ON LINE/OFF LINE	Selects on line or off line mode of operation. (Normally maintained in the ON LINE position unless operating TOP OF FORM switch.)
POWER ON/OFF SWITCH	Controls prime power application to the printer. (Normally left in ON position.)
	NOTE **There are three different audible alarm signals in the LA78 – a continuous tone indicates a carriage jam or failure, repetitive beeping indicates an out of paper condition or a bell code, a single beep indicates a bell tone. If any of these signals occur during operation, perform the remedial actions specified in the LA78 Maintenance Manual.**

Figure C-2   LA78 Printer Operator Controls

LQP-78 Printer
The LQP-78 printer operator controls are shown in Figure C-3. Table C-4 lists all of the operator controls and includes a brief functional description of each.

Refer to the *LQP78 Maintenance Manual* for a description of the paper loading and adjustment controls.

Table C-4   LQP78 Printer Operator Controls and Indicators

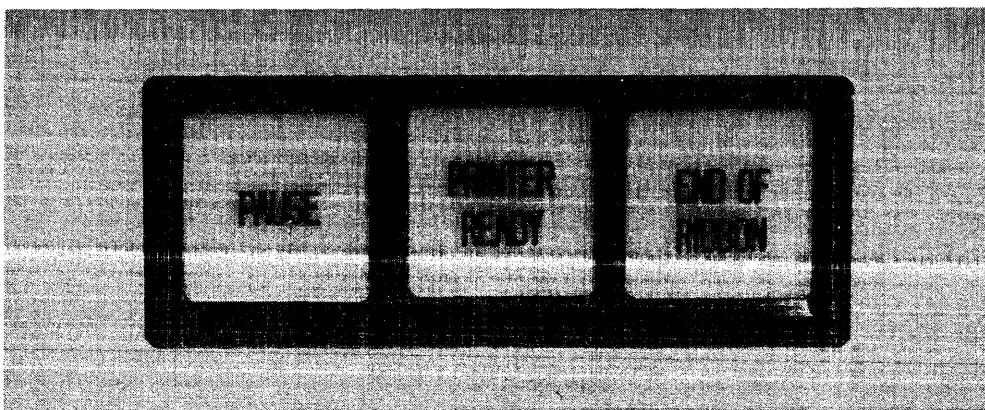| Control/Indicator	Function
PAUSE	Pressed to suspend printer operation. Printer operation is resumed when switch is pressed a second time.
PRINTER READY	Illuminates when prime power is applied to the printer and the printer is ready for operation.
END OF RIBBON	Illuminates when the end of the carbon ribbon is reached.

Figure C-3   LQP78 Printer Operator Controls

Your comments and suggestions will help us in our continuous effort to improve the quality and usefulness of our publications.

What is your general reaction to this manual? In your judgment is it complete, accurate, well organized, well written, etc.? Is it easy to use? _____

_____

_____

_____

What features are most useful? _____

_____

_____

_____

What faults or errors have you found in the manual? _____

_____

_____

_____

Does this manual satisfy the need you think it was intended to satisfy? _____

Does it satisfy *your* needs? _____ Why? _____

_____

_____

_____

☐   Please send me the current copy of the *Technical Documentation Catalog*, which contains information on the remainder of DIGITAL's technical documentation.

Name _____   Street _____
Title _____   City _____
Company _____   State/Country _____
Department _____   Zip _____

Additional copies of this document are available from:

Digital Equipment Corporation
444 Whitney Street
Northboro, Ma 01532
Attention: Communications Services (NR2/M15)
Customer Services Section

Order No. _____

------ Fold Here ------

------ Do Not Tear - Fold Here and Staple ------